THE

ELECTRICAL REVIEW.

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THE BRUSH COMPANY'S REPORT.

IT is somewhat curious that during one of the worst periods of depression for the electrical industry—the end of 1893 and the beginning of 1894—the Brush Company should have been most prosperous. Things are now reversed in a most dramatic fashion, for while most people thought that business in electrical markets was becoming sounder, the Brush Company have recorded one of their worst twelve months. The profit and loss account shows a gross profit of £33,736. Last year it stood at £37,858, in 1894 at £57,157, in 1893 at £49,405, while in 1892 it reached the sum of £55,450. The directors attribute the lamentable decrease to the general falling off in the volume of central station contracts, and partly to the prevalence of unduly low prices for electrical machinery. It is quite clear that the directors cannot be held responsible for the falling off in central station contracts, but as nearly every large town in this country is furnished with a supply station, it is equally clear that a falling off in contracts must ensue. Although it is very easy to talk after the event, still the question is: Have the Brush Company done all they could to adjust themselves to the changing conditions that were inevitable? It is true the report suggests that the future demand for electric traction plant will fully compensate for the shrinkage of orders for electric lighting plant, and no doubt the great resources of the Brush Company will aid them very materially in their competition with other manufacturing companies, but it will need a considerable accession of paying business to extricate them from their unfortunate position.

After considerable agitation on the part of shareholders, the board have permitted the capital item of property, patents, and goodwill to be subdivided, and the result proves that there was reason for the shareholders' agitation, for while the property stands at £88,847, the patents and goodwill figures at the colossal sum of £206,397. No doubt the Brush Company own some valuable patents, including the new Raworth engine, but there must be many that have no great intrinsic value. Moreover, some of the important patents controlled by the company can now only have a short lease of life. It has also to be remembered that the chief of the Brush patents relate to lighting, and though the company may, by the aid of traction, recover its ground, we should imagine that the patents, for which heavy sums have no doubt been paid, will be more or less useless for traction purposes. It seems to us, therefore, imperative that little time should be lost in materially writing down the patents and goodwill. But the high figure at which the patents and goodwill are placed is not the only unsatisfactory item in the accounts. An equally unfortunate feature is the Suspense Account, which stands at £55,439. A careful perusal of the report convinces one that the directors are not sanguine as to the realisable value of this, and suggests the possibility that for all practical

purposes it might be left out of consideration. Indeed, the directors have so little confidence in the sum set down for Suspense Account and patents and goodwill, that they propose to write the shares down £1, for the purpose of wiping out unsatisfactory items in the Suspense Account and the patents and goodwill. The sum arising from the act of writing down the capital will be £90,000, and, substantial as it is, there may be reasonable doubt as to whether it is enough. We must give the directors credit for facing the difficulties of their position, but we are afraid they are a little prone to let themselves down gently. A shareholders' meeting looms in front, we know, but, as sensible men, the proprietors ought to see that there is more hope for the future if they will permit the scalpel to cut deep enough. The result of the year's working may be summed up by saying that though the directors show no confidence in the Suspense Account, the balance of profit and loss, a meagre sum of £4,615, is subject to realising the whole of it. And if the directors are taking steps to wipe out unsatisfactory items in the Suspense Account, what is the true balance from the Profit and Loss Account?

THE MANUFACTURE OF CHLORINE.

This subject was chosen by Dr. Ludwig Mond as a suitable theme for his address at the Chemical Section of the British Association. In choosing this subject he paid a graceful compliment to the City of Liverpool, inasmuch as the neighbourhood round and about produces nearly as much chlorine as all the rest of the world put together, and it is there that several of the most important improvements introduced into the manufacture have been worked out and perfected. Dr. Mond treated his subject historically, starting from the Arabian alchemist, Geber, who, 1,100 years ago, was acquainted with "Aqua regia," and tracing the growth of our knowledge of chlorine right away down to the present time. Dr. Mond has himself been largely identified with the improvements in the methods of producing chlorine, and largely through him the ammonia-soda process has been able to compete with the Le Blanc process, not only in the production of carbonate of soda, but also in the production of bleaching powder. Dr. Mond said, however, in his address, that he had hesitated to extend this process as rapidly as he would otherwise have done, because very shortly after he had overcome all the difficulties, entirely different methods from those hitherto employed in the manufacture of chlorine were actively pushed forward in different parts of the world, and for which great advantages were claimed, but the real importance and capabilities of which were and are, up to this date, very difficult to judge. He referred, of course, to the process of producing chlorine by electrolysis.

During the first decade of this century, Humphry Davy had, by innumerable experiments, established all the leading facts concerning the decomposing action of an electric current upon chemical compounds. Amongst these, he was the first to discover that solutions of alkaline chlorides, when submitted to the action of a current, yield chlorine. His successor at the Royal Institution, Michael Faraday, worked out and proved the fundamental law of electrolysis, known to everybody as "Faraday's Law," which has enabled us to calculate exactly the amount of current required to produce by electrolysis any definite quantity of chlorine. Naturally, since these two eminent men had so clearly shown the way, numerous inventors have endeavoured to work out processes based on these principles for the production of chlorine on a manufacturing scale, but only during the last few years have these met with any measure of success. It has taken all this time for the classical work of Faraday on electro-magnetism to be turned to practical account by means of the modern magneto-electric machine capable of producing electricity in sufficient quantity to make it available for chemical operations on a large scale; for an electric installation sufficient to light a large town will only produce a very moderate quantity of chemicals. In applying electricity to the production of chlorine, various ways have been followed, both as to the raw materials and the apparatus employed. Whilst most inventors have proposed to electrolyse a solution of chloride sodium, and to produce thereby chlorine and caustic soda, yet up to this day no quantity of caustic soda made by electrolysis has been put on the market.

Only two electrolytic works producing chlorine on a really large scale are in operation to-day. Both electrolyse chloride of potassium, producing as a bye-product caustic potash, which is of very much higher value than caustic soda, and of which a larger quantity is obtained for the same amount of current expended. These works are situated in the neighbourhood of Stassfurt, the important centre of the chloride of potassium manufacture. The details of the plant they employ are kept secret, but it is known that they use cells with porous diaphragms of special construction, for which great durability is claimed. There are at this moment a considerable number of smaller works in existence, or in course of erection, in various countries, intended to carry into practice the production of chlorine by electrolysis by numerous methods, differing mainly in the details of the cells to be used; but some of them, also, involving what may be called new principles. The most interesting of these are the processes in which mercury is used alternately as cathode and anode, and salt as electrolyte. They aim at obtaining, in the first instance, chlorine, and an amalgam of sodium, and subsequently converting the latter into caustic soda by contact with water, which certainly has the advantage of producing a very pure solution of caustic soda. Mr. Hamilton Castner has carried out this idea most successfully by a very beautiful decomposing cell, which is divided into various compartments, and so arranged that by slightly rocking the cell, the mercury charged with sodium in one compartment passes into another, where it gives up the sodium to water, and then returns to the first compartment, to be recharged with sodium. His process has been at work on a small scale for some time at Oldbury, near Birmingham, and works for carrying it out on a large scale are now being erected on the Mersey, and also in Germany and America.

Entirely different from the foregoing, but still belonging to the subject, are methods which propose to electrolyse the chlorides of heavy metals (zinc, lead, copper, &c.) obtained in metallurgical operations, or specially prepared for the purpose, among which the processes of Dr. Carl Hoepfner deserve special attention. They eliminate from the electrolyte immediately both the products of electrolysis, chlorine on one side, and zinc and copper on the other, and thus

avoid all secondary reactions, which have been the great difficulty in the electrolysis of alkaline chlorides.

These new processes have, as Dr. Mond pointed out, still to stand the test of time before a final opinion can be arrived at as to the effect they will have upon the manufacture of chlorine. Of course, Dr. Mond does not consider that in electrolytic processes we have reached finality as regards the production of chlorine with the least expenditure of trouble and energy, and in the latter part of his address he attempts to urge chemists to solve the problems before them by purely chemical means, believing that there is plenty of scope left yet in this direction. He does not believe that the easiest way of effecting chemical changes will ultimately be found in transforming heat and chemical affinity into electricity, tearing up chemical compounds by this powerful medium, and then to recombine their constituents in such form as we may require them.

Arc Welding of Steel Steam Pipes and Fittings.

THE constantly increasing use of steam of high pressure, both for marine and land engines, renders the employment of the most suitable and reliable steam pipes a matter of importance to engineers; it was extremely appropriate, therefore, that a paper should be read upon this subject before the Institution of Mechanical Engineers; and the subject was in good hands when it was dealt with by Mr. Samuel MacCarthy. After referring to the peculiar advantages and disadvantages of cast-iron, wrought-iron, steel and copper pipes, and to the later methods of roll welding and gas welding, he proceeded to describe the method of welding by the Benardos arc process. It is in the manufacture and attachment of flanges, branches, bends, and tee pieces, that the Benardos system of welding by means of the electric arc plays such an important part. This process has now been in constant operation for over five years and during this period it has been employed chiefly on large steel pipes and connections, suitable for high pressure steam. The process has been so fully and clearly described from time to time in the various technical and scientific journals, that it is unnecessary to notice it here, before showing its special application in connection with the subject of the present paper. The plant is run on the parallel system; and between the terminals of the dynamos or battery as many welding arcs can be connected as may be desired; and every welder is able, independently of the others, to vary his own current to suit the work in hand at the moment. One terminal of the circuit is connected by means of a flexible cable to a carbon pencil in an insulated holder, which is held by the workman; the other terminal is connected to the table on which the work lies, or to the work itself. When iron or steel is under treatment, it is usual to make the carbon the negative pole, and the iron or steel the positive pole; but for other metals the poles are sometimes reversed. Mr MacCarthy then described the method usually adopted for welding flanges to steam pipes and the welding of outlets, branches, and tee pieces. One point in connection with electric welded work, to which he called special attention, is the length and size of the arc which is used in the welding of various kinds of work. With a short arc the carbon point is brought down too close to the steel, and the result is inferior work, not only from the presence of the carbon, but also because the heat is concentrated upon so small a surface that the strains set up in cooling are considerable. The longer the arc, the softer and more diffused is the heat, and any slight strain which may be set up can be got rid of by careful annealing. A long arc is therefore indispensable to the proper working of the system. All kinds of work can be readily and satisfactorily done by this process; but its utility in large works does not stop here. Small flanges can be heated and welded upon tubes by spinning them in a lathe at a high speed and allowing the arc to play on them, the weld being made by the pressure of two rollers, one inside and the other outside the tube. Defects in steel castings and in finished forgings can be repaired with the greatest ease, and the fact that, when such repaired articles are faced or turned in the lathe, the turnings come away sound and whole, is a proof that the welding has been perfect, and that the metal has not been burnt or rendered brittle by the process.

An American Report on the Overhead System.

A REPORT on electric tramways was submitted to the last Convention of Fire Engineers in America, and unanimously endorsed by that body. This report enumerates all the well known evils which result from leakage currents in the overhead wire tramway, to the gas and water-pipe systems lying underground in the neighbourhood of the tramlines; but no mention is made of the effectual remedies which have now for sometime been worked out and applied by electrical engineers. The experts who drew up this learned report appear to know of no better remedy for electric corrosion in pipes than connecting the pipes to the negative terminal of the dynamo, to prevent the current flowing directly from the surface of the pipes to the ground and the corrosion thereby produced. They appear to be aware that this antiquated remedy increases the current in the pipes and consequently the corrosion at the high resistance joints of the pipes, but beyond this they are unable, or do not care to go. What are we to think of a report that ignores such systems as those of Jackson and Kapp, by which nothing but the smallest trace of current is allowed to enter the ground, and which, at this time of day, can state that "it is the unanimous opinion of this committee that the method of distributing electric currents to street car motors by means of the overhead single trolley and feed wires, track, &c., is a menace to the water and gas systems of every town and city where such trolley systems are in operation." There appears to be much greater need for the German professor in America than with ourselves.

Gas *versus* Electricity.

IT has become the common practice among chairmen of gas companies to make more or less vague comparisons between the cost of gas and electricity, consequently it is not surprising to find that Sir F. Mappin, at a recent meeting of the Sheffield Union Gas Light Company gives some interesting examples of figure juggling. We have already quoted these, and Mr. Morton B. Cotterell repeats them in our correspondence columns for the purpose of demolition. We long ago abandoned the practice of becoming indignant over the remarks of chairmen of gas companies; it is of course irritating to see what are undoubtedly unfair comparisons, but still electricity moves ahead. At the same time we feel disposed to give the gas people an instance of the cost of gas and electricity. In a large town in the north of England a shopkeeper who formerly paid £137 12s. 6d. per annum for gas now pays £77 7s. 11d. per annum for electricity. And it would not be difficult to supplement this by other instances if it were worth while.

THE OERLIKON COMPANY AT THE GENEVA EXHIBITION.

(*Continued from page* 373.)

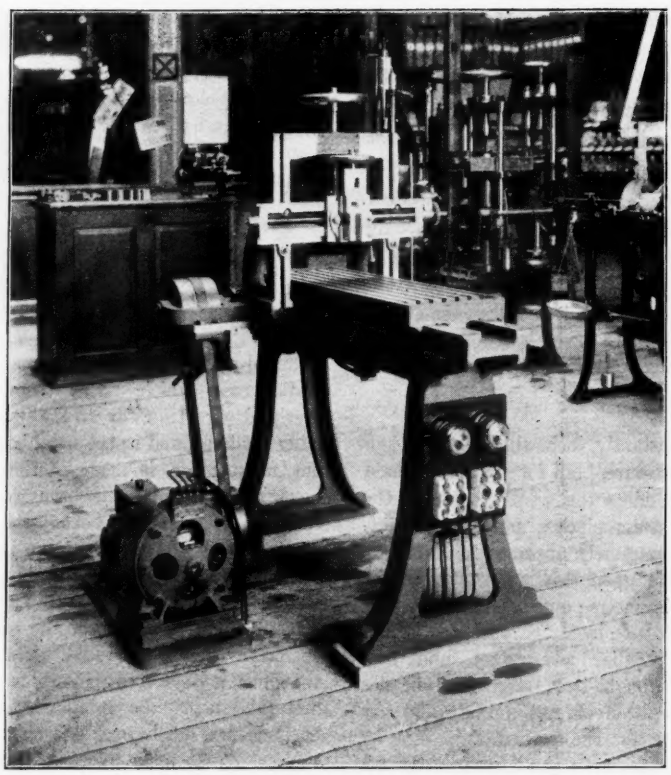
The transportable electric drill mounted on a carriage, is constructed specially for large work difficult to manipulate, machines mounted or being mounted, metal conduits, bridges, boilers, &c. The electromotor can also drive any kind of tool or machine, for instance, screw-hole cutters, borers, &c. The current is conveyed to the motor by a flexible cable of any length, capable of being placed or fastened anywhere. This machine represents an item of production very much sought after.

The two borers for tunnels, mines, &c., are shown in a vault. Each of them is worked by a triphase motor of 2½ H.P., and the drill by gearings and endless screws. They pierce holes 40 mm. in diameter at the rate of advancement of 60 to 80 mm. per minute through granite, and 100 to 120 mm. through calcareous rock.

The universal machine for drilling and cutting screw-holes worked by a continuous current motor, is intended specially for boiler making, and is extensively used in the making and repairing of locomotives. It may be mentioned that the instrument may be inclined in any direction and displaced in any direction.

The lathe for planing and turning, the special lathe for pulleys, and above all the cutting machine with automatic movement in all directions, deserve special attention for their construction, which has been carefully studied with the object of supplying all the requirements in the manufacture of engines.

The cutting machine is worked by a pulley and gearing. The support rises quickly, and its descent may be made at four different speeds, which are easily changed. A handle enables the cutter to be regulated exactly, whilst the axle bearing the cutter is itself regulated by hand by means of gearing. Its advancement is obtained by gearings with differential speed. All the movements of the table to the right and left, forwards and backwards, and also the circular movement, are automatic and effected at four different speeds; they can also be performed by hand. On the support may be placed a supplementary apparatus, cutting at any angle, and another for drilling and cutting screw-holes in any direction.



Planing Machine driven by Oerlikon 3-Phase Motor.

Weaving Machine driven by Oerlikon 3-Phase Motor.

The two machines for shaping the teeth of cylindrical and conical gearings, worked by triphased motors, are of special interest, because instead of cutting the teeth, they shape them according to pattern, and give them in all cases, with all inclinations, exactly the theoretical form.

The machines for working in wood are represented by a horizontal band saw, worked by triphased motors. The principal characteristics of this machine are the perfect sharpness and accuracy of the work done, and its great power of production, the latter amounting to 14 metres of sawing per minute, through trunks 1,400 mm. in diameter.

Side by side with the saw is shown a very interesting accessory apparatus: a machine for sharpening and setting the teeth of the saw, working quite automatically. The edge of the teeth is sharpened by an emery wheel; their inclination and also the advancement of the saw, can be regulated beforehand, so that the machine, when started, works without requiring the least supervision.

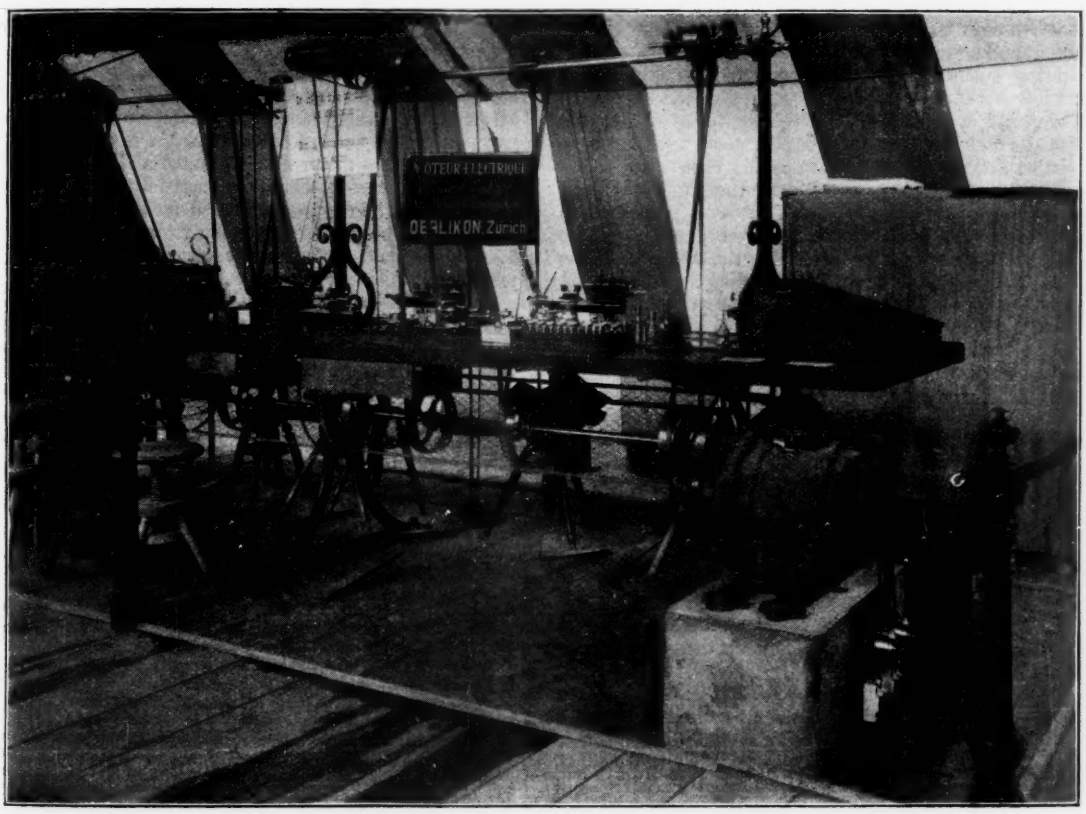
We have now to mention the various applications of electromotors which are demonstrated by the Oerlikon Works among the exhibits of a number of firms requiring motive force to show off their specialities. Amongst these the installation of the Rüti Works is specially worthy of notice. It consists of machines for various trades, each of which is worked directly by its electromotor with an apparatus for

tightening the belt automatically. This mode of working is distinguished by its facility of manipulation and its regularity of working.

The continuous current motors, and also the triphased current motors working the machines, &c., above-mentioned, are driven by two generators worked by a steam engine; the triphased motors for weaving exhibited by the Rüti Works may be fed either by a generator coupled with a steam turbine of the Laval type or by the 20 H.P. alternator coupled with an Escher, Wyss and Co, turbine. The mono- and bi-phased motors, which drive the machines of a number of exhibitors, use current from the system installed by the committee of the Exhibition.

CONCENTRIC CABLES.

Concentric cables are now very generally used, and many advantages have been found to be possessed by them in addition to those which theoretical considerations would indicate.



Clockmaker's Tools Driven by Oerlikon 3-Phase Motor.

Those engineers who have had charge of single cables in early days, and now have concentric mains under their control, are, perhaps, the very best judges of the benefits to be derived, but it is hardly necessary to look to experience alone, as it is self-evident that one cable can be more readily maintained than two, and that any means whereby the number of possible kinds of faults is reduced from three to two would be readily appreciated.

Concentric cables have come into favour very largely owing to the development of alternating current supply, and the progress that has been made in the last 10 years in the manufacture of cables with insulation other than rubber. Jute, fibre, and paper, are only insulators when freed from moisture and protected by a waterproof envelope. This envelope generally takes the form of a lead sheathing, and as lead is a conductor, single cables are out of the question for alternating current distribution. Makers of compound insulated cables perforce had to build the conductors concentrically, for although twin conductors are permissible, the form they take is against them. Once given a concentric cable, and the engineer is not likely to go back to any other form, even should such satisfy his needs electrically.

Mr. J. Hetherington has an interesting article in one of the monthlies* on this question. It is, we can fairly say, one of the most practical papers that has yet appeared on the subject. With the writer's facts there are no faults to be found, but some of his opinions differ from what we think are generally held by station engineers. For example, it is stated that there is an unmistakeable trend in English practice in the direction of lead-covered cables, and that vulcanised rubber as a dielectric is being pushed aside by the cheaper compounds of oil and fibre. Here he goes a little further than facts warrant, for while lead covered compound cables are being largely employed, they by no means hold the market, nor on some of the recent systems are they used to any extent or at all. Rubber of good quality is very nearly as cheap, and certainly is as reliable, as any of its rivals. It is a question of opinion what should be used in any given case, but we do know of stations using rubber insulated mains that have had no trouble, and, we think, need fear none. After all, failure or success is as much a question of laying and maintenance under proper supervision as anything else, and on draw-in systems—which Mr. Hetherington considers unnecessary—the flexibility of an armoured rubber concentric cable has much to recommend it in preference to a lead-sheathed compound cable.

In one thing the article in question goes astray. We are told that triple concentrics are taking a prominent place in three-wire alternating low tension distribution, and that the general use of the 200-volt lamp will greatly increase their usefulness. But unfortunately the Board of Trade regulations in their present form do not allow three-wire 200-volt lamp systems on alternating current supply to rank as low pressure supply at all. Therefore it seems likely that at one blow the triple concentric and the balancing difficulties of

* "Electric High Pressure Concentric Cables and their Accessories," by J. Hetherington, *Cassier's Magazine*, current Volume, p. 382.

the three-wire system will be got rid of by two-wire distribution at 200 volts.

Mr. Hetherington evidently agrees with Mr. Swinburne as to the best means of giving a general supply, putting alternating first, and low tension very low in the scale, high tension continuous being nowhere. But, take what a three-wire 220-volt system can do, as evidenced by any of the continuous current stations, say, St. Pancras, which has a feeder 2,500 yards long. It is unnecessary to go into figures; has not Mr. Addenbrooke exhaustively dealt with the subject? A somewhat neglected paper by Mr. Snell, the electrical engineer of Sunderland, took up the subject so long ago as November, 1894, at the Institution of Civil Engineers, the conclusion being arrived at that for all districts, excepting those which are very sparse, direct current distribution has many advantages and economies over distribution by alternating current. Be that as it may, the old saying that there is ample room for both still holds.

To return to cables, we know that the old Ferranti mains between Deptford and London are being replaced by cable. If they could have been enclosed in a lead tube, so that impervious joints could have been ensured, they would, so says the writer, have been practically a perfect cable for the work. The jointing difficulties were exactly those to which we attached most importance at the time when Deptford was projected, and apparently the obstacles then anticipated have proved too much for the continuance of the rigid mains. That while working at 10,000 volts they should have been short-circuited by wedges, and yet the workmen who caused the damage been ignorant thereof, is a good testimonial to Mr. Ferranti's foresight in one direction. Concentric cables buried direct ought, however, to have their presence indicated by inch boards laid over them, not as a protection so much as a warning, and as notice has to be given to electric lighting undertakers by persons opening the streets, it is the fault of the former if they do not look after their property.

Mr. Hetherington thinks that it is quite proper to make joints on low tension concentric cables with the current on. A recent correspondence in our columns on this very subject proves that he differs in opinion from many other engineers on this point. He, however, would not have such work attempted on high tension live cables; yet, if we remember aright, Mr. Addenbrooke did this very thing in the palmy days of the Grosvenor Gallery supply.

In the complaint that vestries and corporations charge excessive rates for reinstatement where their employés do the work, many people will join. "Where the reinstating is allowed to be done by contractors, it can be done at a fair profit for less than half the average vestry charges, and to the vestry's satisfaction; so that, although municipal labour is a very fine thing, it is not coincident with economy, where a company, without voice or control in its direction, has to settle the bill."

A piece of good advice that cannot be repeated too often is that specifications should not insist upon many megohms, for "high insulation resistance means neither durability nor resistance to disruptive discharge."

It is stated that "there are no high tension mains fused in sections outside the station in England;" but this must have been written in ignorance of what has appeared in our own columns, for there is a system in North London in which this very thing is done.

ELECTRIC MOTORS FOR LOCOMOTIVES.

As one of the editors of the *Railroad Gazette*, Mr. Barnes (of Chicago, not New York), does not usually publish anything without weight, and we can, therefore, hardly regard as "straws" (although they show which way the wind lies), some recent remarks of his before the Western Railway Club of Chicago respecting the speed, power, and efficiency of electric motors for locomotives.

It is, however, very remarkable and noteworthy that some of the leading railway men in the United States should lately have from time to time expressed themselves in no measured terms concerning the excellent prospects before electric traction methods for railway as well as tramway purposes.

Mr. Barnes's paper is of a somewhat elementary nature, as one would perhaps expect, not so much because he himself has but lately taken up the study of electric traction, as because his audience would be almost ignorant of its simplest principles; there is yet, however, no little food for thought in the paper for the most advanced and experienced. We note several very clear expressions and statements—for instance, Mr. Barnes says that often the consequent pole type of motor is used especially for railroad work. "Two of the poles are wound with wire, but the others have no coils around them. They are called the consequent poles, their magnetism being induced by the wires on the other poles." Of course, the object of this method is to save space, the poles being much shallower without field coils.

As a railroad man "accustomed to the great uncertainties of the action of steam locomotives and the inaccuracy and incompleteness of the data and formulæ relating to their power and efficiency," Mr. Barnes has been struck by the "beautiful simplicity and accuracy of the data giving the action of direct current electric motors under variable speeds and loads." To show the relation of speed load and efficiency of such motors is the main object of his paper. He attains it largely by a series of diagrams or characteristic curves, representing the relations of horse-power, torque, efficiency, and speed, both on a basis of current and (as being more useful and familiar to railway men) also of speed. The latter, of course, show the ordinary curve of speed and power values varying inversely at a given pressure.

For instance, a motor normally rated at 100 H.P., running at 780 revolutions (rather a high speed to an English mind for the output!) may vary in speed from 1,200 to 630 revolutions—the power correspondingly changing from 52 to 170 H.P.—the latter being a considerable overload only justifiable for short runs.

Motors under street cars, owing to their exposed position—Mr. Barnes points out by the way—can be run with a greater overload than would be possible if they were in a heated workshop. Some of his conclusions are very interesting, and the following will bear quotation:—

> There is much gratification to be found in the fact that the electric motor, which promises to invade the field now occupied by steam locomotives, is simple in construction and operation, and in the further fact that the relations of speed, power, pull and efficiency can be simply and positively expressed on a diagram readily understood by those who will have charge of the maintenance and operation. It should not reflect, however, on steam locomotive practice that the same complete data cannot now be furnished for steam motors as is offered for electric motors, even although the steam motor has been in use for many years. The complexity of the steam locomotive mechanism and the great variety of factors which affect the economy make it very difficult to reach conclusions, even after a long series of tests, and for this reason we may never hope to be able to draw a diagram or a set of diagrams about any steam locomotive which will express so completely the relation between the speed, power and efficiency as is given for an electric motor. Probably we would not find it so difficult to deduce the relations of these factors for steam locomotives if we had the steam-using apparatus alone to deal with in the steam locomotive, just as we have only the current-using apparatus to treat of in the electric motor. The insurmountable obstacle in the way of a complete exposition of the relations between speed, power and efficiency in the steam locomotive is found in the fact that the steam motor must carry the complete steam generating apparatus. Such apparatus, distorted as it is by the limits of space and weight, cramps and hinders the steam-using mechanism. The electric locomotive when complete with all the essential features for successful practical operation has less weight than is needed for tractive power and the motors need not be cramped for lack of space. This, together with the fact that the power-generating apparatus is fixed at a central station, indicates that the electric locomotive is a simple, and may be made to be a more efficient machine than the steam locomotive; at least all the formulas expressing the operation can be more easily deduced and are more exact in application.

Probably we should be right in deducing from Mr. Barnes's remarks above that he would not think very much of the Heilmann electric locomotive which not only carries a complete steam generating apparatus but an electric equipment also. However it is, we think, admittedly but an intermediate step towards electric locomotives of the simplest possible kind, and may even find itself supplemented before being fairly born into the world. Then everyone would exclaim "D—l take the Heilmann!" even as do some at the present day, though from different motives.

TELEPHONING TO NEW YORK.

By A CABLE EXPERT.

A M. Kildischewsky, of Moscow, announces that he has made an important discovery by which the difficulties of telephoning over submarine cables have been eliminated. With touching *naïveté* he adds that he has tried this submarine innovation on an aerial wire with successful results. A bicyclist might just as well say that he intends to reach New York in the wake of an ocean flyer because he has recently made a successful trip along the Great North Road.

I have met many visionaries of the calibre of this Man of Moscow. One and all threatened to revolutionise the cable service by their telephonic triumphs. The famous Cornelius Herz came to our station in Brest some 12 years ago with a magnificent scheme "destined to work a revolution," and, incidentally, make the fortune of both company and inventor. Alas! no satisfactory results were obtained on the short Brest-Penzance cable. When Cornelius mentioned the long Atlantic cable the managing director smiled and murmured: "*Mon cher*, you are dreaming. *Allons dîner*." And to dinner they went. The next day Cornelius Herz returned to Paris with modified ideas concerning cables.

Two years later an Italian inventor experimented on one of our Atlantic cables and I had the honour to assist him. He brought a complicated machine which he exhibited and dilated on with all an inventor's enthusiasm. What did I think of it? With diplomatic caution I said: "It *might* work!"

In the wee small hours, when the cable was "clear," this affable Italian nobleman and myself took possession of the "string" and worked at the invention like Trojans. Sometimes the signals reached the other end, sometimes they did not. His surprise was as great as his knowledge of cables was small. He swore in Italian, he swore in French, and once, probably out of compliment to me, he evolved a vigorous "Goddam." But the machine did not work, and he finally returned to Rome, announcing further experiments for "next year." I never saw him again and rather fancy he has gone to that unknown land where telephones are superfluous luxuries.

My third inventor I met at an Atlantic cable station in Nova Scotia. He was a smart Yankee with a big scheme "to supersede the miserable system of cable signalling invented by Sir William Thomson." A pretty big contract! He had so pestered the president of the company that the latter ultimately consented to lend him one of his cables for his experiments. The letter written by the president to his station manager was deliciously laconic:—"Dear Mr. X.—I send you a crank. Fix him as you think best."

Thus instructed the manager awaited the arrival of the inventor with his revolutionary machinery. He came. In the course of a preliminary conversation the manager used such ordinary electrical terms as *induction*, *earth currents*, *duplex*, *retardation*, &c. But the inventor had never heard them before and was obliged to ask for frequent explanations. As a matter of fact this crank had never seen a submarine cable, but with sublime "cheek" he announced that he was prepared to improve on the marvellous mirror and syphon recorder invented by Lord Kelvin. Finally, after some vague experiments, he returned to New York a sadder if not a wiser man.

I am really afraid that the coming Russian scientist has not properly realised the practical technical difficulties that beset this scientific problem. Indeed, it is more than probable that he has never seen a cable worked, for he talks of "speaking from the City to New York." This proves his ignorance of the elementary fact that a London-New York line is composed of three distinct sections worked by three separate sets of instruments.

Poor fellow! His journey to London will probably prove fruitless, although he will certainly be kindly treated by the cable companies, ever on the alert for something new and good, and usually doomed to disappointment. But judging from the unreliable data on which he has based his calculations, I am led to the sorrowful conclusion that we are not likely to be called upon to hail any revolution in that branch of science in which Lord Kelvin has attained such eminence.

TELEGRAPH COMMUNICATION WITH AUSTRALASIA AND THE EAST.

We have often called attention to the fragility of the present chain of telegraphs on which Great Britain has to rely for information from India, China, Australasia and the East generally. We have frequently found it our duty to point out the tenuity of each link of the chain on which Great Britain and Greater Britain mutually depend for intercommunication, be it either political or commercial. Writing in England we are, however, placed at a disadvantage regarding time, as we have to depend on the colonial press for information, which it appears is not supplied to our London contemporaries, and which ought at least to have been furnished by public notice to everyone who may enter any telegraph office in England.

We learn on the authority of the *Sydney Daily Telegraph* that (at the beginning of August) "cable messages from England are still delayed owing to the interruption of the lines through heavy floods in India," which is not at all surprising, as the *Sydney Morning Herald* of the day before tells us that "the Postmaster-General received the following telegram yesterday afternoon:—'Delay may be expected on all traffic west of Madras, owing to heavy floods, all lines being interrupted except one between this and Bombay.'"

List of Interruptions and Repairs to Siberian Lines.

Line.	Interrupted.	Repaired.
Siberian landline	6/4/95	9/4/95
" "	22/4/95	23/4/95
" "	25/4/95	28/4/95
" "	1/6/95	3/6/95
" "	7/6/95	7/6/95
" "	20/6/95	22/6/95
" "	27/6/95	28/6/95
" "	28/6/95	2-/6/95
" "	25/7/95	25/7/95
" "	28/7/95	28/7/95
" near Khabarowka	9/9/95	19/9/95
"	7/10/95	7/10/95
"	8/10/95	9/10/95
"	24/12/95	24/12/95
" Blagowestschensk—Wladiwostock ...	8/4/96	8/4/96
" Khabarowka—Anoutchino	24/4/96	25/4/96
" " —Wladiwostock ...	25/4/96	26/4/96
" " Raddé	27/4/96	27/4/96
" between Khabarowka and Wladiwostock	13/5/96	15/5/96
" Blagowestschensk—Raddé	6/6/96	7/6/96
" near Chabarowka	8/6/96	18/6/96
" between Blagowestschensk and Wladiwostock	13/6/96	18/6/96
" between Blagowestchensk et Ekaterina—Nikolsk	3/7/96	4/7/96
" Krasnoiarsk and Kansk	6/7/96	9/7/96
" between Werkhné and Oudinsk et Tschita	20/7/96	24/7/96
" Raddé—Khabarowka	5/8/96	9/8/96
" " "	19/8/96	29/8/96
" Khabarowka—Wladiwostock ...	11/8/96	13/8/96
" Tomsk—Krasnoiarsk	13/8/96	14/8/96
" Omsk—Irkustk	6/9/96	7/9/96
" Ischita—Nertschinska	7/9/96	8/9/96
" Tomsk—Kronoiarsk	12/9/96	13/9/96
" Kabaroswsk—Wladiwostock ...	16/9/96	17/9/96
" near Krasnoiarsk	21/9/96	29/9/96

Some time ago it was pointed out, to those whom it may concern, by Sir Albert Rollit, the President of the Associated Chambers of Commerce, that should the land-lines across India fail through any cause, or during any time of stress ("heavy floods" may be looked on as a mild form of affliction!) England would have to depend for communication with her Eastern possessions on the Russian land-lines which, beginning at the present Russian naval stronghold on the Pacific, Vladivostock, run through Siberia and the Russian Empire generally, until by the grace of another foreign telegraph line, England is reached. It will interest our readers to know that even under the present friendly condition of affairs between Russia and England the lines above referred to are not quite perfect, and it is not difficult to imagine that should the present political position, as regards Russia, become more pronounced, any Englishman whose interests may lie in Australasia and the East might find it worth while to walk across Siberia and hand his tele-

gram in at Vladivostock as being the nearest available telegraph office. We do not conceal the fact that the walk would be tedious, and that the amount payable as porterage on the reply would be considerable, but the value of the information sent and received might warrant such a course.

We give a list of the interruptions which have occurred to the Siberian land-lines during the last two years, and can only hope that nothing will occur to diminish the promptness with which any breakdown in this useful means of communication with Greater Britain has hitherto been repaired.

TESTS MADE BY MESSRS. KÖRTING AND MATHIESEN, LEUTZSCH-LEIPZIG, ON THE "JANDUS" ARC LAMP.

Amongst the new arc lamps, the "Jandus" lamp has called up special interest amongst the electrical world, because the burning time of its carbons is about 13 times as long as the normal time of those of other arc lamps. The saving which results in carbons, and in the time for attending to the lamps, would secure for the "Jandus" lamp a great future; if, on the other hand, material defects had not appeared with regard to the luminous effect. As, however, the cost of the carbons, and of the time for attention in inserting them is far behind the cost of the current, the luminous effect is, of course, the chief question when arc lighting is considered.

The light measurements which have been made by us by means of the Weber photometer have turned out very unfavourably to the "Jandus" lamp, and do not agree with the results obtained by Mr. Edward Houston and Kennelly (see the *Elektrotechn. Anzeiger*, No. 21, of March 12th, 1896). Certainly these latter measured the intensity of the light sources, whilst we have taken into consideration the intensity of the lighting. Of course, both measurements having been made under precisely the same outside conditions, the knowledge of the intensity of the light sources is generally of no practical interest, it being of considerably less importance how many light rays the arc produces, than the question of how much light is available for lighting purposes. Consequently the shape and size of the glass globes, the kind of glass of which they are made, and the position of the arc inside the globe, are important.

Beyond the intensity of the lighting, its constancy, and the degree at which the rays are diffused, have to be regarded.

The arc of the "Jandus" lamp is enclosed in a small inside globe, which is again enclosed in a large outside one. The combination of these two globes forms an essential part of a lamp with a long arc; the light consequently must pass through two glass shades, and this is not necessary with a short arc. A lamp of the latter kind, for inside lighting, is suitably fitted with an alabaster globe. If the "Jandus" lamp would be fitted with an alabaster globe outside, and a clear glass globe inside (so that the thickness of the glass was the same throughout, and the diameter of the outside globe was the same), about equal conditions would be obtained. The "Jandus" lamps, however, are not fitted with an inside globe of clear glass, but, for good reasons, with one of alabaster (certainly favourable for diffused light), by which a double light loss is caused, whilst the light of an ordinary arc lamp need only go through one globe.

If, therefore, the "Jandus" lamp is compared with another lamp, both having the same consumption of energy, and it is taken for granted that both light sources have the same intensities, the "Jandus" lamp would (in consequence of the larger absorption of light caused by its two globes), throw out less light; but this light must, in consequence of the double break, be more diffused than that of an ordinary lamp. This is the case, notwithstanding the quality of the lighting is of less value, for reasons which are connected and associated with the nature of a long arc.

If a long arc, by 70 up to 80 volts difference of tension between the carbons, is so tightly enclosed in a small globe that only a very small quantity of air can enter into this globe, the arc being, therefore, within a mixture of nitrogen, carbonic acid, and other gases, but nearly bare of oxygen, the ends of the carbons become completely flat, and the surface of the top carbon (which throws out the rays) is so abnormally large that the arc cannot cover it; the arc, therefore, is wandering continually round the surface. The consequence of this is, that the radiation of the light takes place chiefly towards one side, and the light would be unbearable if the arc were not surrounded by two globes, which cause equalisation by diffusion. In spite of this equalisation of the partial radiation, the difference of the surface light in the opposite zones is still about 30 per cent. Also, in ordinary arc lamps, there are sometimes one-sided radiations of the light, but then the cause is owing to abnormal conditions, such as inaccurate centralisation of the carbons, or incorrect length of the arc, and the seat of the one-sided radiation remains apart from the abnormal length of the arc mostly unchanged until the cause is rectified; whilst with the "Jandus" lamp the arc never comes to a stand-still, because it is continually searching for the slightest resistance without being able to form a crater.

Continual fluctuations of the light are therefore to be noticed, which, with a view to a fixed point in the room, repeat themselves at short periods, and these fluctuations are of course very irritating, besides which there is also a repeated glimmering of the light, which is somewhat similar to the light of an alternating arc when the alternations are very few in number.

Besides the above-mentioned fluctuations and glimmering of the light, its colour also differs from the light of the short arc; whilst with the latter, under normal conditions, there is little or no violet light noticed; with the long arc this violet coloured light is produced in a large degree. The long arc is distinguished from the short arc in case of air closure, because there is no flame bridge, and because the arc is so intensely violet that a diminution of this light becomes necessary.

Of the existence of "luminous gases" inside the small globe nothing else has been observed. Besides, the violet light which comes from the arc is useless for lighting purposes; the light which comes from the positive carbon is white, just as in other lamps, and forms the largest part of the total light produced.

From the foregoing it is evident, with the "Jandus" lamp, that the two globes around the arc must consist of glass, which diffuse the light very much, in order to make the light somewhat useful for inside lighting; that is, if the one-sided radiation has been equalised as much as possible, and if the glimmering as well as the violet colour of the light has been reduced. When comparing measurements this necessity must be considered; and consequently the measurements of the surface lighting are alone to be dealt with, in so far as not only scientific researches, but more particularly practical conditions are to be taken into consideration.

It is to be further noted that the eyes are more dazzled by the "Jandus" lamp than by an ordinary lamp with alabaster globe and with the same light effect.

When making our photometer measurements, we had at our disposal a main current "Jandus" lamp for 5 amperes. The same burned, when the measurements and trials regarding the length of burning time were made, with a potential of 75 to 80 volts in parallel on a 110-volt circuit, so that about 30 volts had to be absorbed in resistance. Still, the consumption of energy was only supposed to be 500 watts, as nominally a 100-volt tension should be sufficient.

According to this consumption of energy, one shunt lamp of our make, pattern "F," was worked with 9·1 amperes, and taken to consume a tension of 55 volts | 500 watts, as two lamps are burning in series on a 110-volt circuit. Two series of measurements were made, the first one with those carbons which were supplied with the "Jandus" lamp, marked "Electra," of which the positive carbon was solid too; and the second measurement with Siemens "A" carbons of the same dimensions, of which the positive carbon was cored, however. With the "Electra" carbons the lamp burned 186 hours, and with the Siemens carbons 165 hours; the total length of both was 460 mm. With the Siemens carbons the glimmering of the light was diminished a little, while the wandering of the arc was naturally the same. Below we give the results of the measurements which were made in seven very different but accurately fixed places, in a room with white ceiling and light yellow walls of 4 metres height. The plane surface consisted of a glazed white cartoon, which was 1 metre from the floor, whilst the distance of the arc from the ceiling was the same in all measurements.

1. Measurements with 186 Hours' Burning.

Jandus lamp with "Electra" carbons.

Dimensions:—
Top carbon 306 × 13 mm., solid.
Bottom carbon 153 × 13 mm. solid.

Result at the commencement of burning:—	
Ordinary lamp, 46 meter candles average ...	= 100%
Jandus lamp, 29 „ „ „ ...	= 63%
Loss of light	= 37%
After 86 hours' burning:—	
Ordinary lamp, 48 meter candles average ...	= 100%
Jandus lamp, 27 „ „ „ ...	= 55%
Loss of light	= 44%
Average loss	= 40·5%

2. Measurements with 165 Hours' Burning.

Jandus lamp with Siemens "A" carbons.
Same dimensions. Top carbon cored.

Result at the commencement of burning:—	
Ordinary lamp, 44 meter candles average ...	= 100%
Jandus lamp, 32 „ „ „ ...	= 73%
Loss	= 27%
After 90 hours' burning:—	
Ordinary lamp, 41 meter candles average ...	= 100%
Jandus lamp, 24 „ „ „ ...	= 58·5%
Loss	= 41·5%
After 165 hours' burning:—	
Ordinary lamp, 43 meter candles average ...	= 100%
Jandus lamp, 20 „ „ „ ...	= 46·5%
Loss	= 53·5%
Average loss	= 40·7%

The ordinary lamp burned always with Siemens "A" carbons with a tension of the arc of 42 volts; the diameter of globe was 400 mm., while the diameter of the "Jandus" globe was 335 mm.

From this statement it is evident that the lamp with a normal arc in all the measurements gave nearly constant lighting values; whilst the lighting values of the "Jandus" lamp very much varied. In both measurements the lighting values diminished with the "Jandus" lamp in time, the cause of this being due to the increasing grey residue

inside the small globe. This residue was formed under perfectly normal conditions, as the globe was not opened during either of the two burning periods.

For outside lighting, the luminous effect of the "Jandus" lamp will be still more unfavourable, as then the reflection of ceiling and walls, which is necessary for this lamp does not exist; in consequence of which, one of the globes would then have to be of clear glass. When a diminished absorption and greater lighting is obtained, the wandering one-sided light effect and the violet light become so prominent at the same time, that no profit results.

Trials made with alternating current have terminated in negative results. The alternating current arc cannot do without a flame-bridge, in consequence of the current-value which passes through the 0 point. The conductivity of the gases which pass between the two carbon ends, diminishes so much in the moment, when the current changes, that it passes only by very short distances of the carbons.

In the "Jandus" constant current lamp of 5 amperes, 80 volts, the length of the arc is about 8 mm., whilst with an alternating current lamp of 8 amperes, 55 volts, carbons 30 mm. diameter, there is hardly any arc to speak of. Augmented air supply makes the arc, according to the supply, correspondingly larger; in the same degree, however, the residue of the small globe increases, so that the luminous effect and the burning time will be diminished in the same manner.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, LIVERPOOL, 1896.

(*Continued from page* 401.)

ON A COMPLETE APPARATUS FOR THE STUDY OF THE PROPERTIES OF ELECTRIC WAVES.

By Jagadis Chunder Bose, M.A. (Cantab.), D.Sc. (Lond.), Professor of Physical Science, Presidency College, Calcutta.

(*Read in Section A, September 21st*, 1896.)

Arrangement of the Apparatus.

The radiating apparatus and the receiver are mounted on stands sliding in an optical bench. Experiments are carried out with divergent or parallel beam of electric radiation. To obtain a parallel beam, a cylindrical lens of sulphur or ebonite is mounted in a square tube. This lens tube fits on the radiator tube, and is stopped by a guide when the oscillatory spark is at the principal focal line of the lens. The radiator tube is further provided with a series of diaphragms by which the amount of radiation may be varied.

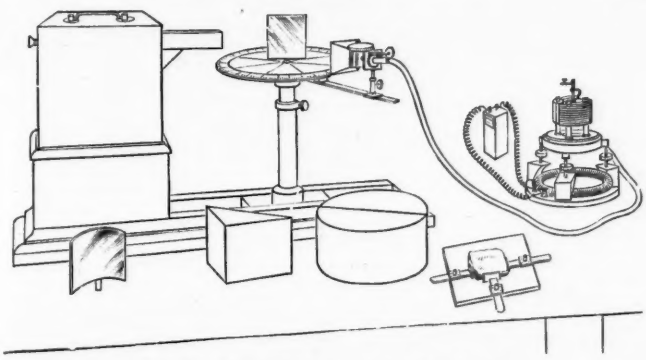


Fig. 4.—Arrangement of the Apparatus.

For experiments requiring angular measurement, a spectrometer circle is mounted on one of the sliding stands. The spectrometer carries a circular platform on which the various reflectors, refractors, &c., are placed. The platform carries an index, and can rotate independently of the circle on which it is mounted. The receiver is carried on a radial arm (provided with an index) and points to the centre of the circle. An observing telescope may also be used with an objective made of ebonite, with a linear receiver at the focal plane. But an ordinary receiver provided with a funnel is all that is necessary for ordinary experiments.

Laws of Reflection.

Plane Mirrors.—A parallel beam is used. The spectrometer circle is adjusted with the zero division opposite to the radiator. The platform index is turned to zero, and a plane reflector placed on a previously marked diameter at right angles to the index. The receiver is placed say at 60°. The platform carrying the mirror is slowly rotated (electric radiation being at the same time produced by tapping the key), till the receiver suddenly responds. It would now be found that the platform index points to 30°, midway between the radiator and the receiver.

Curved Mirror.—A cylindrical metallic mirror, with a radius of 25 cm., is placed on the platform, with its principal axis coinciding with the platform index. When the radiator is placed at a distance of 25 cm. from the mirror the source of radiation would be at the centre of the cylinder. The reflected image will now be formed at an equal distance. The receiver mounted on the radial arm (at a distance of 25 cm. from the centre) is placed at a given angle; the platform is rotated till the receiver responds. The index would now be found to bisect the angle included between the radiator and the receiver.

Refraction.

Deviation of the Electric Ray by a Prism.—An isosceles right-angled prism is made of sulphur or ebonite. Parallel beam is used. For showing deviation by refraction one of the acute angles is interposed on the path of the beam.

Total Reflection.—An interesting experiment on total reflection is shown in the following way:—The receiver is placed opposite to the radiator, and the prism interposed with one of its equal faces at right angles to the direction of the ray. The receiver will remain unaffected. The critical angle of ebonite being considerably less than 45°, the rays undergo total reflection. On turning through 90° the receiver responds to the totally reflected ray.

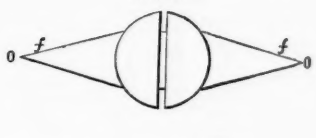
Opacity Due to Multiple Refraction and Reflection.—An experiment analogous to the opacity of powdered glass to light is shown by filling a long trough with irregular-shaped pieces of pitch, and interposing it between the radiator and the receiver. The electric ray is unable to pass through the heterogeneous media owing to the multiplicity of refractions and irregular refl ctions, and the receiver remains unaffected. But on restoring partial homogeneity by pouring in kerosine, which has about the same refractive power as that of pitch, the radiation is easily transmitted.

Determination of the Indices of Refraction.—Two semi-cylinders of the given substance separated by an air film is placed on the platform. When the radiator is placed at the principal focus of one of the semi-cylinders the rays emerge parallel into the air film, and are then focussed on the receiver by the second semi-cylinder. A metallic plate with a narrow rectangular opening is interposed between the semi-cylinders to serve as a diaphragm, and cut off all but the central rays. As the platform is rotated, the incident angle on the plane surface separating the two media is gradually increased till the rays undergo total reflection. When this is the case the receiver ceases to respond. The index reading is now taken, and the cylinders rotated in an opposite direction till total reflection takes place a second time. The difference of readings as given by the index in the two positions is evidently equal to twice the critical angle. Hence the value of the index can easily be deduced.

A preliminary experiment gives the approximate value of the index, from which the focal distance of the semi-cylinder is roughly calculated. The spark gap of the radiator is placed at this focus, and the experiment repeated. In this way I have determined the indices of refraction of several solids for the electric ray (*vide Proceedings* of the Royal Society, Vol. 59). The index of refraction of commercial sulphur is = 1·73; that of a specimen of pitch = 1·48.

Indices for Liquids—A cylindrical trough is filled up with the given liquid; two thin parallel glass plates enclosing an air film are vertically placed so as to divide the liquid cylinder into two halves. The readings for total reflection are taken as in the last case. The index for coal tar I found to be 1·32.

Fig. 5.



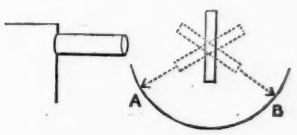


Fig. 6.

Selective Absorption.

A substance is said to be coloured when it allows light of one kind to pass through, but absorbs light of a different kind. If we take into account the entire range of radiation, there is hardly a substance which is not, in this sense, coloured. In the spectrum of radiation transmitted through glass, for example, two broad absorption bands would be observed, one in ultra-violet and the other in the infra-red, the electric and the visible rays being not absorbed to any great extent. A brick or a block of pitch would absorb light, but would transmit the electric ray. On the other hand, a stratum of water, though transparent to light, would absorb the electric ray. These substances exhibit selective absorption, and are therefore coloured.

If we only take into account the electric radiation, it would no doubt be found that radiations having different wave-lengths are unequally absorbed by different substances.

Phenomena of Interference.

Determination of the Wave-Lengths by Diffraction Grating.—In a paper read before the Royal Society in June last, I have given an account of a method of obtaining pure spectra of electric radiation by means of a curved grating. The experiment was carried out with a large apparatus. The spectrum obtained was well defined, and

appeared to be linear, and not continuous. I had not time to adapt the experiment to this small apparatus, but I think it would not be difficult to do so.

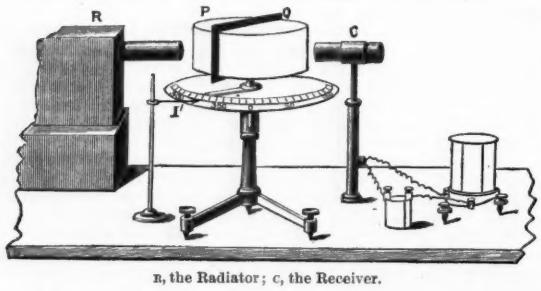
Double Refraction and Polarisation.

The spectrometer circle is removed, and an ordinary stand for mounting the receiver substituted. By fitting the lens tube the electric beam is made parallel. At the end of the lens tube there is a slot in which is dropped the wire grating polariser. A crystal holder provided with three sliding jaws is fitted on the lens tube, and is capable of rotation round an axis parallel to the direction of the electric ray.

The receiver carrying the analyser is also capable of rotation round a horizontal axis by means of a tangent screw. The angular rotation is measured by means of an index fixed to the analyser, and a graduated vertical disc.

The gratings are made by winding fine copper wire, parallel, round square frames. Other forms of polariser will be described later on.

The spark gap is placed vertical, and the polariser is adjusted with wires horizontal. The emergent beam is now completely polarised, the vibration taking place in a vertical plane passing through the axis.



R, the Radiator; C, the Receiver.

Fig. 7.

The analyser, fitted on to the receiver, may be placed in two positions:—

1. Parallel position. When both the gratings are horizontal.
2. Crossed position. When the polarising grating is horizontal, and the analysing grating vertical.

In the first position, the radiation being transmitted through both the gratings, falls on the sensitive surface, and the galvanometer responds. The field is then said to be bright. In the second position the radiation is extinguished by the crossed gratings, the galvanometer remains unaffected, and the field is said to be dark. But on interposing certain crystals with their principal planes inclined at

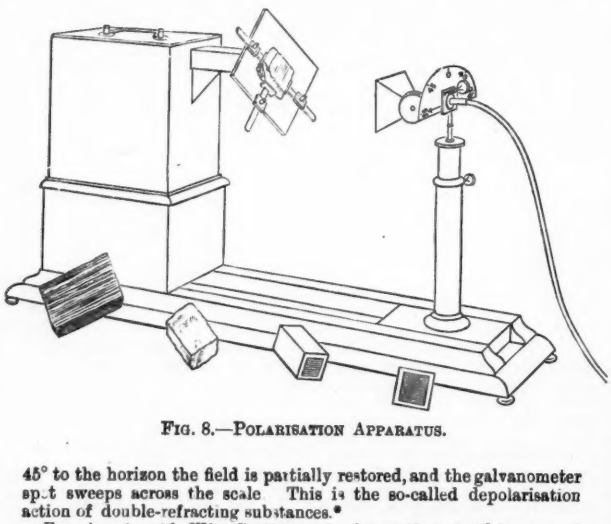


Fig. 8.—Polarisation Apparatus.

45° to the horizon the field is partially restored, and the galvanometer spot sweeps across the scale. This is the so-called depolarisation action of double-refracting substances.*

Experiments with Wire Gratings.—A wire grating at 45° interposed between the crossed analyser and polariser partially restores the field, but ordinary wire gauze does not transmit any radiation, the action of one set of wires being neutralised by that of the other set at right angles.

Double Refraction Produced by Crystals.—The crystals to be examined are mounted on the holder, and properly inclined. Double refraction is shown by all crystals belonging to the Rhombic, Rhombohedral, Triclinic, and Monoclinic systems. The effects exhibited by the following are very marked:—

1. Serpentine. This crystal, which appears fibrous, transmits the ordinary and the extraordinary rays with unequal intensity. A fairly thick piece would absorb vibrations parallel to the fibres, and transmit vibrations perpendicular to the fibres. Ordinary radiation, after transmission through a thick piece of serpentine, would be plane polarised, the vibration taking place perpendicular to the fibres.
2. *Nemalite.*—This crystal exhibits this effect in a still more marked degree.
3. Tourmaline also produces the depolarisation effect. The difference in absorption of the ordinary and the extraordinary rays, is, however, not so great as in the case of light.
4. Beryl is also very good crystal for exhibiting the depolarisation effect.

Polarisation Produced by Other Substances.—I found many other natural substances producing polarisation, the most interesting being vegetable fibres. Common jute (*Corchorus capsularis*) exhibits the property in a very marked degree. I cut fibres of this material about 3 cm. in length, and built with it a cell with all the fibres parallel. I subjected this cell to a strong pressure under a press. I thus obtained a compact cell 3 × 3 cm. in area, and about 5 cm. in thickness. This was mounted in a metallic case, with two openings about 2 × 2 cm. on opposite sides for the passage of the radiation.

This cell was found to quench vibrations parallel to the fibres, and transmit vibrations perpendicular to the fibres. Jute cells could thus be made to serve as polarisers or analysers.

Effect Due to Strain.—Could be exhibited by stratified rocks, the plane of stratification being inclined at 45° to the horizon.

Effects similar to that produced by unannealed glass can be imitated by a block of unequally chilled paraffin.

The polarisation apparatus above described may also be used as a polarimeter, the rotation of the analyser being measured by the graduated disc.

* For a detailed account of experiments on the polarisation of the electric ray, I would refer to my paper read before the Asiatic Society of Bengal, May, 1895, and two subsequent papers published in the *Electrician*, December 27th, 1895.

ELECTRICAL DISTURBANCES IN SUBMARINE CABLES.

By W. H. Preece, C.B., F.R.S.

(*Paper read before Section A, September 23rd*, 1896.)

Many interesting problems arise from time to time in the practical applications of electricity which tend to develop, or confirm theoretical deductions on a scale beyond the dreams of the laboratory experimenter. In no branch has this been more pronounced than in submarine telegraphy. Long-ocean cables contain invariably only a single core.* Multiple cables, that is, cables possessing more than one core, are usually short in length, are, in consequence, free from those disturbing elements which, existing in long lengths, make such circuits difficult to operate successfully. A *disturbance* is the result of the expenditure of energy in the wrong place. It tends to loss of efficiency. In telegraphy this means mutilation of signals and loss of speed in working. In telephony it means indistinctness of speech, the presence of extraneous and distressing sounds, or the reduction of distances through which speech is practical.

The longest multiple cables worked by the British Post Office are those connecting the coast of Suffolk and Norfolk with Germany, and these cables have four cores each.

The following table gives their lengths and particulars:—

Name of cable.	Date laid.	Length in naut. miles	Capacity in microfds. K.	Resistance in ohms. R.	K. R.*	Remarks.
Lowestoft-Norderney	1866	225	73·1	2,710	198,100	No brass tape.
Lowestoft-Borkum ...	1871	225	66·0	2,666	175,950	„ „ „
Bacton-Borkum ...	1891	211	63·0	2,380	149,940	„ „ „
Bacton-Borkum ...	1896	224	84·0	1,500	126,000	Separate brass tape round each core.

* The product K R expresses the law that the time constant of a circuit varies as the product of its active capacity and its ohmic resistance.

The Norderney and other cables in the North Sea having been attacked and punctured by the *Limnoria terebrans*, a small boring mollusc, it was decided to cover the cores of all new cables with brass tape armour, an effective remedy against this depredator. Hitherto brass tape had been used solely for this particular purpose. It was wrapped round the whole of the cores after they were stranded together; but, for other reasons which will appear, the second Bacton-Borkum cable, laid this year, had each core separately and independently so protected.

These four cables, forming 16 circuits, are worked as a rule by the Hughes type-printer; but on two circuits, the double-current-Morse system is employed. In all cases the earth is used as the return. The presence of disturbances from induction was first seriously brought under notice after the laying of the Bacton-Borkum cable in 1891. This cable is one of the ordinary four-core P.O. standard type, without any brass taping, a section of which is shown in fig. 2. On commencing to work the four wires, it was found that, although we had a perfect cable, with better copper, and gutta-percha of lower static capacity than usual, yet the Hughes working upon the four circuits was very unsatisfactory. Twelve months after its submersion, a series of observations was made upon the three then existing Anglo-German cables, when it was made clear that there was still

* The term *core* is applied to the copper conductor and its insulating sheath or dielectric.

very much more disturbance upon the 1891 Borkum than upon the old cables viâ Lowestoft. After very careful examination and consideration it was concluded that the difference was due to the better mechanical condition of the new cable, upon which the compound was still practically sound, preventing a complete and continuous soaking with water of the hemp yarn around and between the cores, with the consequent absence of the shielding effect which existed in the older cables, owing to their more thorough saturation. It was consequently assumed that the new cable would improve with age. But this disturbance presented itself in a more serious manner when attempts were made to work *duplex* Hughes, and also when testing the Wheatstone automatic system upon one of the cores. It was

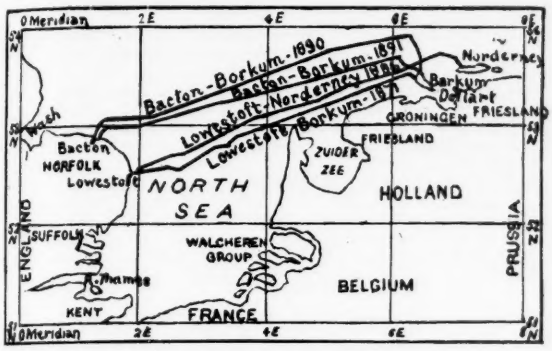


Fig. 1.—Map of Part of North Sea, Showing Bacton-Borkum (2), Lowestoft-Norderney and Lowestoft-Borkum Cables.

found that duplex Hughes was just possible, but owing to the disturbance from the other cores the signals were mutilated so frequently that working was too unreliable for ordinary business. The disturbances from Wheatstone working were still more serious. The Hughes apparatus is worked by short sharp, intermittent currents, separated from each other by varying intervals of time. These time intervals determined the letter to be printed.

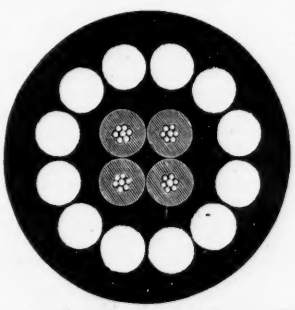


Fig. 2.—Ordinary 4-Core Submarine Cable. Deep Sea Type. 107lbs. Copper, 150lbs. G.P. to scale.

The causes of disturbance are induction and leakage. The latter may be ignored, for the insulation of our cables is practically perfect. The induction may be either *electrostatic* or *electro-magnetic*. The former is the primary agent in reducing the speed of working in telegraphs, and in deteriorating the clearness of speech in telephones. A part of the energy of the current is absorbed by the capacity of the line, and stored up as a charge producing in discharge retardation and prolongation of signals. Electrostatic induction between core and core is the principal cause of the disturbance between the conductors of multiple cables. Electro-magnetic induction also produces serious disturbances on straight parallel circuits with earth return, whether used for telegraphs or telephones; but between the two wires of a metallic circuit it may have a very beneficial influence in telephone working.

It is very easy to differentiate the electrostatic from the electro-magnetic effects. The former differ in direction at each end of the circuit when discharging. The latter maintain the same direction throughout. The former vary with the *voltage*, and the latter with the *amperage*.

During the experiments with the Wheatstone system, to which I have referred, it was found that the disturbances on the Hughes circuits, due to automatic sending on another core of the same cable, increased with the rate of working. Thus, with the same voltage, viz, 80, at

Key speed (30 words per minute), the effect was negligible.
Automatic (40 words per minute), the effect was distinct.
Automatic (50 words per minute), the effect was serious.
Maximum speed of the cable (70 words per minute), the effect was prohibitive.

The greatest disturbances were observable when automatic and Hughes were working in opposite directions. The signals on the Hughes were sometimes in advance and sometimes in retard. Hence they were so greatly mutilated that Hughes working was impossible. This was due to the consonance which occurs in two parallel circuits. When the mutual inductive influence, either electrostatic or electro-magnetic, or both, between them, produces in either conductor greatly increased or greatly diminished currents, the one will advance and the other retard the signals so as to render telegraphy impracticable. The brass tape around each core entirely shields the conductors from electrostatic induction. The separate and independent brass taping of the 1896 cable has fully complied with my anticipations. The disturbances upon the cables are reduced to a negligible extent. They are one-sixth of those observed on the 1891 cable. They would entirely disappear if we could remove the electro-magnetic effects. The possible rate of working, after several months' submersion, on the new cable, is 33 per cent. greater than on the 1891 cable, but this is due chiefly to the reduction of the K R. The improvement in the signals is shown by the two recorded curves (fig. 3).

The time constant* of the 1891 cable is 0·0513 second, and that of the 1896, 0·0450 second, measured by the Hughes instrument, which is a capital chronograph.

Part II.—Telephone Cables.

An important form of multiple cable to consider is that required for telephone working. The cable connecting England and France, forming the Channel section of the London-Paris telephone circuit, has cores of the ordinary type, as shown in fig. 2, using gutta-percha as the insulating medium, but with its capacity and resistance reduced to a minimum. It gives two circuits between London and Paris, and works very satisfactorily; but we want to bridge over greater distances, and eventually we hope to reproduce speech even across the Atlantic. The Dover-Calais type would not do for a greater distance than, say, 30 nautical miles. The distance to Belgium is 47 nautical miles, to Holland 108, to Germany 211 nautical miles. With paper as the dielectric, having half the specific inductive capacity of gutta-percha, and with our later experiences of air spaces, cannot we devise a new form of cable that will bridge over these greater distances? We must eliminate all disturbances, and we must reduce capacity and resistance to their lowest limits. The former is simple, for well-insulated, symmetrically twisted metallic circuits are free from all external disturbances. The latter is more complicated, and is surrounded with great practical difficulties. The problem is to diminish the time constant of a metallic circuit so that it shall approach zero.

If there were no time constant, current waves would rise instantly to their working maximum, and as rapidly fall to zero. If we could materially diminish the causes of retardation in such cables, speech by telephone would be possible to great distances. This can be done theoretically by neutralising the effect of static capacity by the opposite effect of electro-magnetic induction.

The conditions which retard current waves and thus determine the time constants in single conductors embedded in a solid cylindrical dielectric are very different to those which act in double conductors or parallel metallic loops. Lord Kelvin in 1855 dealt with the cases of direct currents and distributed capacity in a complete single circuit.

The surface of the conductor in such a cable is one plate and the earth the other plate of a condenser. At every point of the course of the current this capacity must be satisfied. Work is done on the dielectric in establishing an electric field. Lines of electric force are formed through the medium, varying in number with the force

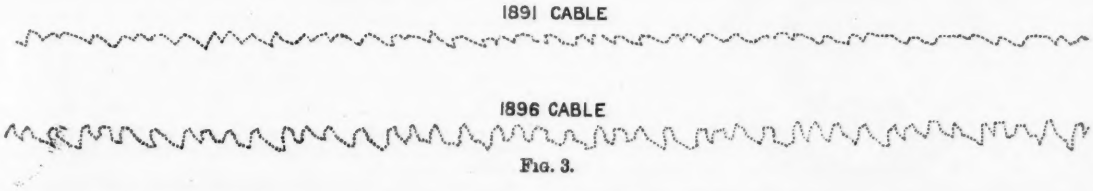


Fig. 3.

exciting them, and with the thickness and specific inductive capacity of the dielectric. Energy is stored up. The charge thus held must be neutralised or dissipated. Discharge to earth through each end is the result, and this, with the resistance of the circuit, produces retardation of signals.

Neutralisation has been attempted in submarine telegraphy by sending reversed currents, but with only partial success.

With parallel conductors and telephone working the conditions are

* The *time constant* here referred to is the time that the current takes to rise to the necessary strength to work a relay in normal adjustment.

very different. The total energy expended in any circuit in a given time may be considered under three heads:—

1. That expended in overcoming resistance.
2. That expended in producing the electric field.
3. That expended in producing the magnetic field.

In each case we must consider the energy stored up and that dissipated. The former tends to retardation, the latter to work done, and therefore to reduction of efficiency. Careful regard must be paid to the directions in which the different disturbing forces act, for it may be that they oppose each other, and direct the energy into the original channel under modified and more favourable conditions. Thus, if the whole effect of the electrostatic field is neutralised by that of the electro-magnetic one, the total energy developed is expended on the circuit itself, disturbances are eliminated, and the service improved. This is the case of a metallic circuit having a microphone transmitter at one end and a telephone receiver at the other. The capacity of such a system will tend to store up a portion of the energy of each current, but the electro-magnetic induction between them will tend to supply the deficiency. If the two wires of the loop be far apart the influence of mutual induction will be much less than that of capacity. As they approach, the electro-magnetic induction must increase at a greater rate than that of the electrostatic induction, until, finally, at the limit when they coincide, the one must exactly neutralise the other. This, perhaps, is better seen if we consider the case of a concentric cable; for, in this case, the number of lines of electric force does not increase, while the number of lines of magnetic force cutting the other conductors does increase rapidly as the outer conductor approaches the inner. The maximum induction from each source must take place when the two conductors are infinitely near each other, and this maximum must equal the primary current, for it cannot exceed it unless there were fresh creation of energy. Thus, as the separating dielectric becomes smaller and smaller, the two effects approach each other closer and closer, until, at absolute

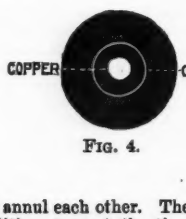


Fig. 4.

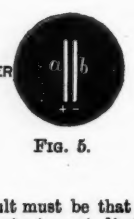


Fig. 5.

contact, they annul each other. The result must be that if these be the only conditions present, the time constant must diminish as the two conductors approach each other, and in the limit it must disappear. Twenty miles of concentric cable (fig. 4), insulated with paper, were made and laid in the streets of London to test this reasoning, and comparisons were made with ordinary parallel cylindrical conductors, insulated both with gutta-percha and with paper and air. The results were very encouraging; but an unsuspected difficulty arose from the want of symmetry of the capacity of each conductor and the earth. The insulation resistance of each conductor was also different, and the result was that when the concentric cable was joined to overground wires, serious disturbances were experienced in the working circuits, which, however, were remedied by crossing the conductors of the concentric cable at several points, so that each side of the circuit was sometimes the inner and sometimes the outer conductor. This, however, is a cure that could not easily be applied to a submarine cable. It is clear that in such a cable symmetry of capacity with earth and of insulation is essential.

The experiment with the concentric cable shows that we have to consider not only the capacity between the two conductors, but that between each conductor and earth. Symmetry can be produced if the conductor be shaped and arranged as in fig. 5. Only a certain

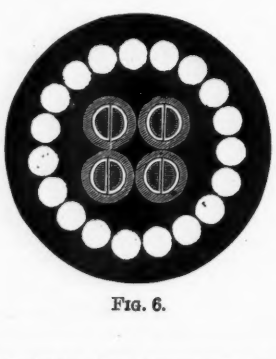


Fig. 6.

number of lines of electric force, dependent on the voltage present, can emanate from each conductor. The closer a and b (fig. 5) are to each other, and the further they are from the earth, the greater the number of lines between the conductors and the fewer to the earth. The electric field is, in that case, confined almost entirely to the space between a and b.

Taking the transverse action upon each element of such a core working telephones, each conductor is a source of periodic and opposite alternating electric force, and a displacement current passes through the dielectric that separates a and b, varying not only with the electric forces and the specific inductive capacity, but with the frequency of the alternations. There is no storage of energy. It is dissipated as heat, but this heat, with the very small amount of energy expended in telephone working, cannot be sensible.

Taking the longitudinal action per unit length of each conductor, since there is no storage, but only a small expenditure of energy between the conductors, the rate of fall of voltage must be slightly greater than that required by Ohm's law. It does not, however, cause retardation, because that is the result of storage and release of energy. It is different, however, with the condenser action between each conductor and earth. Here there must be some storage of energy, but, for the reason given, this must be small; and in an insulated system like a telephone circuit, and with a thick dialectric sheath, the effect may possibly be neglected.

The problem resolves itself into a practical question: What is the best form to give the cable with our existing experience and our available materials? My present solution is given in fig. 6. The conductors are insulated first with paper and then with a thick coating of gutta-percha. Paper only exists between the conductors. The cable is sheathed and compounded in the usual form. There are four circuits, instead of two, as at present in the London-Paris cable.

With such a cable I have little fear of speaking between England and Germany; but to test the practical points that arise in the manufacture of such a cable it is proposed to make and lay a short one to the Isle of Wight. If my reasoning is correct, and so far experiment has confirmed it, then not only ought we to be able to speak to great distances, but the type of ocean cables would be revolutionised, for what is true for telephony must be equally true for telegraphy. Cables such as those across the Atlantic might, with the same weight of copper, be made to transmit a greater number of words per hour than they do now.

(*British Association Proceedings continued on page* 442)

A GAS ENGINE DRIVEN ELECTRIC INSTALLATION.

The *Blackpool Times*, in a recent issue, speaks of the lighting of the Empire Theatre. It appears, says our contemporary, that the Empire people were rather staggered when last year's bill for electric lighting was sent in. When a representative of the National Gas Engine Company, of Ashton-under-Lyne, called on them and declared they could do the work just as well, and a good deal cheaper, they were inclined to make the experiment. Accordingly they placed in the basement of the building a 55 actual horse-power National gas engine, and a National dynamo capable of supplying 640 16-candle-power lamps. The plant was put to work on the afternoon of July 8th, the gas meter being a new one, standing at zero. On September 5th the gas meter stood at 276,000, and the electrical meter at 5,970. As the electrical meter was not connected until July 17th (having been delayed in transit), it is estimated that at least 1,000 units of electricity had already been supplied, giving the following result:—With 60 days' working, the electricity supplied amounted to 6,970 units. which, at the Corporation's price of 6d. per unit, gives £174 5s. From this is deducted the following working expenses:—

Gas used on engine, 276,000 at 2s. 4d.	£32	4	0
Nine weeks' wages engineer, at 30s.	13	10	0
Oil, waste, &c.	2	10	0
Total	£48	4	0
Subtract this from the Corporation charge, and the gross saving for nine weeks, exclusive of interest, is	£126	1	0

At this rate the saving would be about £750 per annum, at the same rate of use throughout the year, and the plant would pay for itself directly. The first week 40 hours 15 minutes were worked, 30,400 cubic feet of gas were consumed, and 790 units supplied. In the second week 43 hours were worked, and from 31,700 cubic feet of gas 820 units were supplied. Third week, 35 hours 10 minutes, 26,800 cubic feet of gas, and 690 units; fourth week, 44 hours, 35,300 cubic feet of gas and 865 units; fifth week, 41 hours 40 minutes, 35,500 cubic feet of gas, and 875 units; sixth week, 39 hours, 34,700 cubic feet of gas and 840 units; seventh week, 40 hours 10 minutes, 36,600 cubic feet of gas and 903 units. One of Thomson-Houston's continuous-current recording wattmeters, which has been specially installed, is used, so that the above results are thoroughly reliable.

The gas engine is specially constructed for electric light purposes, the cranks being completely balanced from the centre, and the bearings are so massive, that the usual vibration attending a large gas engine is completely obviated. The governor of the engine, which is of a special and patent construction, is driven direct from the crank-shaft, and its efficiency is at once apparent when seated in the theatre, as notwithstanding the fact that the stage lights are constantly being thrown off and on, the theatre lights are kept perfectly steady, which, in the case of gas engine driving, has hitherto been very difficult.

In order to make the plant more complete, and not to interfere with the lighting of the offices when the engine is not working, a switch-board has been erected in the engine-house, upon which is mounted the necessary instruments. The ordinary Corporation supply is connected to these, as well as the supply from the dynamo.

CORRESPONDENCE.

"Electricity in Mines."

The attention which has been given to this subject during the last two months in the Review, commencing with the excellent articles contributed by Mr. Kennedy, and followed by yours on "Electricity Down a Coal Mine," and by "Is our Coal Industry in Danger," leads me to think that a little discussion of it from the mining engineer's point of view will be acceptable, although the last question raised, as to the help which can be given in the reduction of cost, and extending the life of some of our old coal mines, is, I fear, too large to be adequately dealt with in the compass of an ordinary letter.

With Mr. Kennedy's articles I think I may safely say that I am in entire agreement. His statements as to the relative efficiency of electricity and compressed air, exactly meet my views, and I have used both now and given careful attention to them for nearly 20 years, although when giving voice in support of compressed air in the way that he has done, I know I have been considered on many occasions as treating electricity from a prejudiced point of view. I admit that 95 per cent. of those who use compressed air refuse to believe in the necessity for cooling it during compression by water spray, and that they therefore obtain very low efficiency, but that is no reason why we should accept their low efficiencies when comparing it with electricity.

Mr. Kennedy has given this subject so clearly, that I need only point to one omission, which is very natural on his part.

In the case of rock drilling in coal mines, it is generally used in the case of a stone drift, where there cannot be any permanent returns; in such cases the air is carried in by brattice and the place is warm; here the coolness afforded by the expansion of the compressed air has a special value.

Before I leave the question of efficiency, I may point out that at the three large collieries with which I am connected, our boilers are entirely heated by coke oven gas, and this now applies to many other collieries. In such cases, efficiency becomes of small moment.

There is another omission, namely, all reference to hydraulic power, and where large permanent pumps are employed underground, this system is capable of giving very high results. The water, raised to a pressure of 700 lbs. or more, goes down to the pumps by one range of pipes, and returns by another.

The information he gives with respect to the various types of dynamos, with their cables, commutators, and other fittings, is, I think, very valuable, being written from an entirely unprejudiced point of view, and should be kept for reference by all interested in such matters.

Electricity down a Coal Mine.—In the case described, the hauling machine appears to be near the shaft bottom; then, where the depth does not exceed, say, 600 feet, I prefer to have a steam engine on the top, and take the hauling ropes down the shaft. You then have no intermediate motor to require an attendant and consume power, but where situated as the pumps appear to be, say, 1,200 yards in-bye, then the value of electricity has very strong claims upon our attention, especially where the heat for boilers has to be got from coal.

In the case in question, the drum shaft is driven from a counter-shaft by means of spur gearing, and the motor drives the counter-shaft by six 1-inch cotton ropes, which are probably necessary to get the speed down, but must lead to an important loss of power.

We are then told that the "capital required was only half that for compressed air," but as this is based upon the old story of 30 per cent. efficiency for air, which Mr. Kennedy shows clearly to be unwarranted, it is open to a considerable amount of criticism, and may fairly be said to be erroneous; the plant at Abercanaid is evidently a good one, and doing useful work.

Now we come to the question raised in yesterday's Review as to the assistance which may be given to our coal industry, in these times of closing large collieries, by the use of electricity.

We have to remember that the colliery you particularly refer to has been working for 50 years, and that during the early life of a mine all its nearest and best coals are worked out first, and if, as you say, in the case in question, it has been losing latterly very heavily, the disease is probably too deeply seated to be cured by either electric haulage, coal cutting or pumping. There is, I believe, no pumping. Water is seldom met with at such a depth in this district, and it would therefore be necessary to consider only haulage and coal cutting.

With respect to haulage, in the year 1855 the late Mr. Nicholas Wood gave the Northern Mining Institute a paper on "The Conveyance of Coals Underground," and returned to the subject in 1857, when, at the particular colliery in question, he described the hauling arrangements in which both boilers and engines were underground. Now, however objectionable that may be from some points of view, it is one calculated to work cheaply.

In 1865, the same Institution appointed a committee, afterwards known as "The Tail Rope Committee," and they, with a paid engineer and secretary, examined and thoroughly tested with indicator and dynanometer, all the various systems of haulage then in use, and they issued a long and valuable report. They have since had various other committees of a similar kind on such subjects as "Ventilating Fans" and "Coal Dust Explosions."

If they or any similar institution could be induced to take up the question of electrical haulage, I think it would prove very useful; but it costs a lot of money, and the members of the committee have to devote to it a great deal of valuable time.

With respect to coal cutting, this is a very important matter, and if under the arrangements for safety described by Mr. Kennedy it can be made a success, no one will be better pleased than myself; but you see it at once raises the question of machine *versus* hand-labour, a knotty one—as for instance:

In this day's issue of *Industries* I read: "Owing to the threats of a strike on the part of the miners, the Bridgewater trustees have consented to withdraw the electric coal cutting machine, or iron man."

No better proof of its value could be given, and probably it is only to await a better organised attempt, although such a surrender is very regrettable, it is difficult to introduce machinery alongside of handwork—the whole pit should be put to work by the system at once. In this district, owing to clean seams of coal, packing material is not available, long wall, and therefore coal-cutting machines cannot be applied.

Finally, as to lighting. The economy in this branch which can be effected is too small to merit much consideration. At three large collieries the cost of oil for six months is:—Hewers' lights, 0·05d.; all other lights, 0·13d.: or less than ¼d. per ton of coal, and this includes everything except the labour of cleaning lamps.

Now, in 1882, I believe I was the first who ever applied electricity to light a colliery; after nine months I had a letter from the head offices with a Dr. and Cr. account, showing that after allowing 7½ per cent. on the capital, "the use of it during the nine months ending September 30th last has entailed a loss of £182 7s. 11d., or rather the extra lighting has cost this sum." In this there appears to be nothing charged for coals.

Soon afterwards the heapstead was burnt down, and I did not renew the light; but since that time, no doubt, much improvement has been made in all the appliances, and where a good light is wanted for cleaning the coals, it seems probable that the extra cost, if any, would be well covered.

A. L. Steavenson.

September 26th, 1896.

[From the bottom of the shaft at the Abercanaid Colliery to the electrical hauling plant is about 800 yards, and this portion is operated by a steam engine on the surface working an endless rope. It is that portion of the mine beyond the 800 yards endless rope system that is worked electrically. The high efficiencies obtained by Mr. Kennedy for compressed air plants were obtained by heating the air at the motor end, a method generally inadmissible in collieries.—Eds. Elec. Rev.]

Gas v. Electricity.

Your report in last week's issue of the chairman's speech at the Sheffield Union Gas Light Company contains some very interesting information, but at the same time lets in

the light on a mode of reasoning adopted with some success by the opponents of electricity.

On the occasion in question the chairman, Sir F. Mappin, drew attention to the case of the consumers of electricity at Nottingham.

These consumers had had the electric light laid on, and had used it for a clear year. They had paid for their gas, during the previous year, £3,215. In this year their gas bill was reduced to £2,336, but their electric lighting bill cost them £2,386; or altogether for the year, £4,723. Consequently gas costing £879 was replaced by electricity which cost £2,386. Therefore the estimate they had heard made as to the difference in cost of electricity and gas had been pretty well maintained, and showed that electricity was 2·71 times as dear as gas was.

I am glad the relation is carried out to two places of decimals: it is so much better to be exact in these matters. One is accustomed to regard gas shareholders as more or less shrewd individuals, but if they are able to comfort themselves with such ingeniously distorted arguments as this, they must indeed be becoming guileless. Next year a few more gas engines and another dozen or two gas cooking stoves may—for the want of better substitutes—be adopted by Nottingham electricity consumers; if by these means they consume, say, another £800 worth of gas, it will be possible for the chairmen of gas companies to increase the relative cost of electricity considerably, for will they not be able to make the remark that gas costing £79 has been displaced by electricity which cost £2,386, clearly showing that electricity is 30·202533 times as dear as gas?

But to reduce this ingenious reasoning to absolute absurdity, it is only necessary to state it in formula shape,

$$\frac{\text{Annual cost of electricity}}{\text{Annual cost of gas}} = \frac{\text{Amount of electricity bill}}{\text{Difference of gas bills.}}$$

So that in the case of a shopkeeper who instals a couple of arc lamps outside his premises at an annual cost of £20, his gas bill for the interior lighting remaining the same, we have—

$$\frac{\text{Annual cost of electricity}}{\text{Annual cost of gas}} = \frac{20}{0}$$

or electricity is *infinitely* more expensive than gas!

The gas companies have my full permission to make what use they like of this argument.

Morton B. Cotterell.

King Street, Covent Garden,
September 28th, 1896.

X Radiation at the B.A.

Kindly allow me to point out a slip which has crept into the report on p. 417, of my communication to the British Association on cathode and Röntgen rays. The important point of my observation with the particular tube described was not that cathode shadows are produced in the tube at low exhaustions, and Röntgen shadows outside the tube at high exhaustions. These were already known. The point of my observation was that at the high exhaustion the two sets of shadows being simultaneously produced, one inside the tube on its walls, the other outside on a luminescent screen, differ in this respect, that the latter remain unaltered in shape and position during the time when the former are being distorted or shifted by electrostatic or magnetic influences applied to the tube. The experiment of watching the double set of shadows, one sensitive to these forces, the other entirely indifferent to them, is the more striking, because the both sets of shadows are present *at the same time*.

Silvanus P. Thompson.

September 29th, 1896.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—A deed of assignment for the benefit of creditors has been executed by Thomas Lomax Harrison, electrical engineer, Back Church Street and 30, Devonshire Road, Blackpool, under which Mr. John Taylor, 67, Church Street, Blackpool, accountant, is trustee. The unsecured creditors are returned at £221, and the assets, after deducting the claims of preferential creditors payable in full, are returned at £115.

Electrical Wares Exported.

Week Ending Sep. 29th, 1896.	£	s.
Alexandria	50	0
„ Teleph. mtl.	140	0
„ Teleg. wire	264	0
Antigua	10	0
Antwerp...	21	0
Bangkok...	300	0
Bombay	455	0
„ Teleph. ...	38	0
Brussels	602	0
Buenos Ayres	216	0
„ „ Teleg. mlt.	183	0
Calcutta	247	0
Cape Town	288	0
„ Teleg. mtl.	4,550	0
Delagoa Bay	15	0
Durban	155	0
Flushing...	9	0
Gothenburg. Teleg. wire	192	0
Jersey. Teleg. mtl. ...	18	0
Launceston	870	0
Leghorn	100	0
Lisbon. Teleg. mtl. ...	11	0
Madras	204	0
Malta. Teleg. mtl. ...	64	0
Marionpol	2,147	0
Mollendo	14	0
Otago	17	0
Perim. Teleg. mtl. ...	102	0
Port Elizabeth	461	0
Rangoon	10	0
Rotterdam	55	0
St. Petersburg	252	0
Shanghai. Teleph. mtl.	37	0
Singapore. „ „	19	0
Stockholm. Teleg. mtl.	155	0
Sydney	493	0
Trinidad	8	0
Wellington	129	0
„ Sub. cable	4,300	0
Yokohama	110	0
Total	£17,318	0

Week Ending Sep. 29th, 1895.	£	s.
Algoa Bay	61	0
Bilbao	98	0
Barcelona. Teleg. mtl.	12	0
Bombay	40	0
„ Teleph. mtl....	70	0
Cape Town	679	0
„ Teleg. mtl....	70	0
Colombo...	26	0
Corinto	19	0
Delagoa Bay	350	0
East London	1,639	0
„ Teleph. mtl.	56	0
Gibraltar. Teleg. mtl....	282	0
Kurrachee	30	0
Launceston	25	0
Malta	5	0
Melbourne	290	0
„ Teleg. mtl....	745	0
Port Natal	54	0
Rotterdam	18	0
„ Teleg. mtl....	13	0
Santos. Teleg. mtl. ...	449	0
Suez	19	0
Sydney	68	0
Wellington. Teleph. mtl.	167	0
Yokohama	7,119	0
„ Teleph. mtl.	6,253	0
Total	£18,666	0

Foreign Goods Transhipped.

	£	s.
Adelaide...	48	0
Bilbao	31	0
Total	£79	0

Cardiff Corporation v. Pedlar.—At Cardiff Police-court last week, a claim was made against Wm. and Nesley Pedlar, of 113, Queen Street, Cardiff, for certain sums, £9 18s. 6d. and £6 4s. 10d., in payment for supply of electric current. An order was made for payment.

Changes of Address.—The office of *Sciences and Commerce* (*Revue Pratique de L'Electricité*) has been removed to 9, Faubourg Poissonnière, Paris.

Mr. Sidney à Court has removed from 19, Old Queen Street, S.W., to more commodious offices in Artillery Mansions, 75, Victoria Street, S.W., to which building he is consulting engineer.

Dynamo Magnet Steel Castings.—Messrs. Elgar Allen and Co., Limited, of Tinsley, Sheffield, in a list on the magnetic qualities of their patent dynamo magnet steel castings, give a copy of a report made by Prof. J. A. Ewing, in April last, on tests conducted by him. He examined five samples of the steel, one of which he had already tested in 1894, and remarks that there is but little difference between the results obtained in 1894 and those obtained this year for the same sample. In view of recent improvements in his appliances and method of testing, Professor Ewing considers the new tests are probably more accurate. The results give important evidence not only of the high permeability, but also of the uniformity of these castings. Curves and tables accompany the report, and the professor concludes with the following:—"Taking all five samples together, the range of variation throughout the upper region of the curve is remarkably small. The close agreement of the various samples with one another, under the action of such magnetising forces as are used in dynamos, is most satisfactory, especially when the difference in date of the castings is borne in mind. All my tests of your cast steel confirm the impression which I formed in 1894 that it is an exceptionally good material for dynamo magnets. So far as tests made on a limited number of samples can prove, it may be relied on to take up, under the action of any assigned magnetising force exceeding 30 units, an amount of magnetism which is not only absolutely very high, but is capable of being stated beforehand within narrow limits of probable variation."

For Sale.—From our "Official Notices" particulars may be obtained of a sale which is to be effected of the plant, machinery, fixtures, patterns, drawings and stock-in-trade of the Wigston Electrical and Engineering Company.

Fined.—Paul Lax, of 49, Moorgate Street, E.C. was fined £5, including costs, at Marlow on 24th ult., for navigating the electric launch, *La Seine*, without due care and caution on the Thames at Marlow on July 19th, and thus endangering the safety of other boats.

The London and Lancashire Electric and General Engineering Company was, on Tuesday, fined at the North London Police Court £10 and costs for not complying with the Factory Acts, by allowing a gas engine and other machinery and gearing to work without being fenced or railed off. The magistrate described the neglect as a "gross attempt to evade the Act," and imposed the full penalty.

H. M. S.—Messrs. H. M. Salmony & Co. have removed from 61, Charing Cross Road to Nos. 118—120 in the same road. The new premises are extensive, and well adapted for a business of this nature. A dry, well-ventilated and well-lighted basement affords good quarters for machinery, cable, mouldings, and the engine and dynamo for lighting the building. The ground floor is the sales department, one side being devoted to bells and telephones, and the other to lighting accessories. At the back is a capacious warehouse, so that everything in demand in these lines is ready at hand for delivery. The first floor forms an extensive show-room for fittings, the ceiling and walls being elaborately wired, so that current can be switched on to any single fitting or group. The second floor is devoted to offices, and the top floor to workshops and lamp stores. Its central position, as well as the extensive frontage, and the exceptionally good light thus obtained from basement to roof, render this new establishment of Messrs. Salmony & Co. one of the finest and most convenient in the trade.

Jandus Arc Lamp.—A new list, giving 10 pages filled with testimonials received by the Jandus Arc Lamp and Electric Company from users of this lamp, has been issued.

Lamp Reflector.—A small but not unimportant article has been patented by the "National" Glow Lamp Reflector Co., of Manchester, which is made of tinned iron, cut in the centre, of a suitable size for fixing round the lampholder for incandescent lighting. The rays of light are consequently reflected down instead of being absorbed by the fitting.

Measuring Instruments.—A very neatly prepared catalogue of voltmeters, ammeters and indicators, has been issued by the Stewart Electrical Syndicate, Limited, of 103, New Oxford Street, W.C., who are agents for the Whitney Electrical Instrument Company of the United States. The list includes particulars and illustrations of direct-reading voltmeters and ammeters for continuous and alternating currents, divided scale instruments, switchboard instruments for continuous current, Whitney potential indicators for alternating currents, &c.

Price Lists.—Messrs. Peto & Radford, of the Hatton Garden Electric Works, have just issued lists of their pocket and portable accumulators (2, 4 and 6 volt), cycle sets, apparatus and accessories, electric jewellery (scarf pins and hair ornaments, &c.), hand lamps and lanterns, and large accumulators for carriage lighting. Illustrations, prices, and general particulars are given.

Time Checkers.—The Keighley Electrical Engineering Company, Limited, of Alexandra Works, Keighley, are the sole makers of the automatic electric time checking machines, of which they have sent us several lists. The lists show and give particulars and prices of machines for use with metal checks, autograph machines, the automatic watchman's control for asylums, hospitals, factories, banks, &c. This company has a variety of other electrical specialities, such as indicators, alarms, switches, &c., and also supplies the "Keighley" dynamo.

Traction Specialities.—Mr. R. W. Blackwell, of 39, Victoria Street, S.W., has just issued a number of lists dealing with the various electric traction apparatus and specialities which he supplies. One of the lists—issued by the Standard Paint Company—gives particulars of the P. and B. compounds, insulating paper and tape, varnish, &c., and details the application of the P. & B. composition in traction work, both in the power station and on the line. A price list of the Chicago rail bonds, a circular describing the Edison-Brown plastic rail bond, a list of the Peckham Motor, Truck, and Wheel Company's cantilever extension trucks; also Mr. Blackwell's own list (No. 4, dated September, 1896), of insulators, line material, and special appliances for electric tramways, complete the collection.

Electric Pump.—Messrs. Crampton & Co., of Yarmouth, have just completed an electrically worked pump for Messrs. Back and Co., wine merchants. The plant consists of a motor, which is connected with the Yarmouth Corporation mains. The pump is of the three-throw type, and delivers water to two large tanks in the roof at a cost of 2d. per hour.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Consideration of the scheme for electrically lighting the Harbour has been deferred. It is not expected that the new system can now be brought into use for the coming winter.

Ballater Station.—For the occasion of the arrival of the Emperor and Empress of Russia *en route* for Balmoral, the Great North of Scotland Railway Company hired from the Corporation of Aberdeen the necessary plant, paying all expenses, and £5 per day for the hire. The Aberdeen Town Council had the matter before it last week, and objection was taken to the plant being lent without the permission of the Council. Two councillors seemed greatly upset over the matter, and even went so far as to move an amendment declining to approve of the Gas and Electricity Committee's action. The arguments of these two councillors were weak as water. There was a great fuss about nothing. Councillor Johnston, however, was quite capable of taking care of himself, and he dealt with Councillor James Gray's objections in splendid style, with a result which could only be expected, *i.e.*, that only the proposer and seconder voted for the amendment. If the Committee had the plant to spare during this comparatively light season surely it was entitled to let it out on favourable terms without bringing so trifling a matter specially before the Council.

Blackburn.—For the post of assistant electrical engineer (£125 per annum) there were 51 candidates; three of these have been selected, and a choice will shortly be made.

Bodmin.—An electrical engineer has written to the Council proposing a municipal electric lighting plant, and offering to act as electrical adviser. Referred to Lighting Committee.

Bradford.—A proposal has been made to separate the Gas and Electricity Supply Committee into three bodies, to manage matters relating to the gas, electricity, and chemical departments respectively. The matter has been deferred.

Bridlington.—A new hotel, costing £40,000, to be built on the Marine Drive, is to be lighted electrically.

Brighouse.—The Town Council last week decided that the Council at once take steps to obtain the sanction of the Board of Trade for permission to supply electricity within the borough. This is with reference to the purchase of Mr. A. B. Brook's electric lighting undertaking.

Bristol.—The Western Counties District of the Incorporated Association of Municipal Engineers met in Bristol on Saturday, and during the day paid a visit to the Civic electrical works, and to the electrical power station of the Bristol Tramway Company. Mr. Faraday Proctor was down on the agenda to read a paper on the "Civic Electric Lighting Station," of which he is engineer; but as he was upon his wedding trip, his place was taken by Mr. J. R. Blackie, the assistant engineer.

The Electric Light Committee having considered the electric lighting estimates for the coming half-year, find that they will not require to make any call upon the rates towards the expenses of the undertaking. But they will require to make a call for public street lighting, and this will amount to £2,380. The engineer reports that the new engine has now been fixed and will be running in a day or two. The committee decided to dispose of their gas engine plant, which is too small to be of service any longer.

Brixton Theatre.—We understand that this electric lighting plant, to which we referred last week, broke down on Tuesday night, and in consequence there was no performance in the theatre.

Chiswick.—With reference to the electric lighting station, the surveyor at the last Council meeting said that as things stood at present, the electric lighting system could be established in four or five months.

Dover.—The Council had a lengthy discussion this week regarding the lighting of Biggin Street and Cannon Street. It was a question of gas or electricity. We learn that it was resolved that the streets be lighted by nine arc lamps at a cost of £270 per annum, or £147 more than the gas company's offer to light with 33 incandescent gas lights.

Dublin.—The local Press complains that the electric lamps in a number of streets were not lighted on the night of 27th ult.

Dundee.—The Gas Committee has under consideration the proposed extension of the electric lighting system, by lighting many of the principal thoroughfares. Mr. Tittensor recommends that 60 arcs be used for the purpose.

Edinburgh.—While "the Rev. Professor Kennedy" was conducting a service at the Newington Parish Church, Edinburgh, on Sunday, the electric light suddenly failed, leaving the place in darkness. We have become so used to associating Prof. A. B. W. Kennedy's name with Edinburgh's electric light installation, that we wondered for a moment whether he held the dual position there of parson and consulting electrical engineer!

Fleetwood.—The Council has entered into an arrangement with a London firm for the disposal of their powers under the Electric Lighting Order, and when the sanction of the Local Government Board has been obtained, operations will at once be commenced for the putting down of an installation. The sum paid for the transfer of the order is £600.

Fulham.—The County of London and Brush Provincial Company has written to the Vestry, asking that before a final decision is arrived at with respect to applications for provisional orders, they may have the opportunity of attending and placing before them the advantages which they were able to offer with respect either to taking over the order which they might obtain, or as to the terms which they would agree with them beforehand, as was done last year in the case of their application from Camberwell. They might mention that their station at Wandsworth was now approach-

ing completion. The delivery of plant had been commenced, and they would be in a position to supply current from there and for the coming winter's lighting. Their mains were already laid to Putney Bridge, and in the event of their consenting to their proceeding with their application, they could continue along across Putney Bridge, laying their mains throughout their district and giving a supply direct by the autumn of 1897. They would also propose to make it part of their agreement that the Vestry should have the option of purchase within a short term of years of the whole of the distributing mains. The letter has been referred to the Electric Lighting Committee.

Glasgow.—Trinity Congregational Church was lighted on Sunday by electricity for the first time. The coronas have five 50-C P. lamps on each. Messrs. Wm. Bryden & Son, of Glasgow, carried out the work.

Gorton.—A councillor gives notice that he intends to propose that the Council apply for electric lighting powers, or that arrangements be made for getting a supply of gas, either on their own account, or in conjunction with some neighbouring authority.

Hackney.—The Hackney Vestry, we understood, was supposed to have an electric light and refuse destructor scheme in hand, and was to borrow £80,000 for carrying it out. The exact situation of the matter, however, is known to very few persons, it seems, and even vestrymen cannot get the information, for one asked at the last meeting, but no satisfactory reply was forthcoming.

Hampstead.—The Electric Light Committee reports that the number of applications for current received up to the present date was 450, of which 417 were connected, with an equivalent of 31,602 8-candle-power lamps, as compared with 385 applications and 355 connected, with 25,292 lamps, on June 25th.

Hoylake.—The District Council has resolved to take no further action regarding the proposed purchase of the gas works, but to make application for an electric lighting provisional order.

Hull.—The Committee referred to last week has appointed Mr. Robert Hammond to examine and report upon the scheme of electric light extension which has been under consideration at Hull.

Leicester.—Alderman Lennard, Chairman of the Gas and Electric Lighting Committee, reported, on Tuesday, that the working of the electric lighting department for the half-year ending June 30th last had resulted in a loss, after charging £584 on the sinking fund account, of £723 0s. 5d., after taking credit for £151 14s. 6d., the profit from the electric lighting fitting business. This amount, together with £1,337 17s. 8d. lost on December 3rd last, made a total loss in connection with this department of £2,060 18s. 1d. The total amount which had been paid on the sinking fund was £1,882. The Committee had spent during the year £2,176 19s.; and they still had an unspent balance of £6,861 14s. The revenue from the sale of electric current had risen from £671 to £1,467 12s. 6d., an increase of £796. The total revenue was £1,670, against £963, a total increase of £707. Their expenditure fund had got up from £863 to £1,254 14s. 8d., the principal portion being for wages, while they had £68 3s. to pay for taxes, which they had not to pay before. The balance carried to profit and loss account was £415 11s. 8d. The net loss up to December 31st, 1895, was £1,337, and the loss for the half-year ending June 30th was £723, making a total loss of £2,060. This half-year they had more than double the number of consumers, and in the next half-year the profit would counter-balance the loss on the first half-year, making a level balance-sheet for the year. A reduction in the price of the current from 6d. to 5d. per unit is to be made from January 1st next. The report was then adopted.

Liverpool.—The Lighting Committee is to recommend the Council to adopt a scheme for lighting London Road and Lime Street by electricity. 20 arc lamps will be used.

London.—The Trocadero Restaurant has been fitted up for electric lighting by Messrs. Strode & Co. The premises are wired on the new conduit system, the whole of the cables and wires being drawn into specially prepared wrought-iron tubes, insulated inside, and screwed together, and arranged with inspection boxes in convenient positions, so that the whole of the cables and wires can be drawn into the tubes after they are fixed, and can be withdrawn at any future time for inspection. The great advantage of this system is that the whole of the tubing of the building can be done during the progress of the building, thus avoiding any unnecessary cutting away. The insulating material used for coating the inside of the tubing does not allow of any condensation or rust forming inside to destroy the insulation of the wires. The handsome arc lamp brackets and columns, and other electric light fittings throughout the building have been supplied and fixed by Strode & Co. The same firm have also fitted up the whole of the steam supply pipes, steam urns, and teak sinks.

Mr. T. Spurgeon has started an electric lighting fund for the purpose of installing electricity in the Metropolitan Tabernacle instead of gas, which he finds vitiates the atmosphere so as to render preaching very difficult.

Maidstone.—The electric lighting question has been hanging fire here for some years. The latest moves are the following:—(1) The Municipal Electric Lighting and Power Corporation, Limited, has given notice of its intention to apply for a provisional order; (2) Mr. W. C. C. Hawtayne has made a new proposal for carrying out the Council's provisional order, and the Electric Lighting Committee is making inquiries; (3) Mr. Thomas King gives notice that unless the Council intend to proceed at once with their provisional order, he proposes to lay electric lighting cables across certain streets in the borough. With these three proposals we should think something practical will shortly result.

Motherwell.—The electric light has now been turned on in the new premises of Messrs. G. & J. Maclachlan at the Cross.

New Swindon.—A sub-committee of three councillors and the electrical engineer, Mr. Aldridge, has been instructed to visit certain towns and inspect the electric lighting stations and report. The proposal of a company to take over the provisional order has been rejected for the present.

Preston.—The Wesleyan Chapel, Moor Park, is being lighted throughout by electricity. About 120 lights are being installed by Mr. Thomas Barton, of Blackburn.

Ship Lighting.—The ss. *Narrung*, just built by the Sunderland Ship Building Company for Mr. Lund, of London, has a very complete electric light installation, which was fitted up by Messrs. H. Binko & Co. This consists of a vertical engine and a direct working dynamo, giving a continuous current of 160 amperes at 105 volts. There are 235 16-candle-power lights provided, including a considerable number of portable lamps, and four cargo lights, each of which is provided with four 32-candle-power lamps. The side lights, masthead light, and anchor lamp are all electric, and the compass and ship's telegraph are also fitted with an electric light. All the fittings in the saloon are of solid white metal. The saloon and smoking room are heated by electricity.

Southampton.—The Electric Lighting Committee last week reported the receipt from the Local Government Board of the following sanctions to loans:—For the purchase of the undertaking, £21,100 for a period of 15 years; for new buildings and extension works and mains, £28,900 for 25 years; and for the purpose of additional land, £5,300 for 50 years. The Town Clerk had been instructed to apply to the Local Government Board for an extension from 25 to 30 years for the repayment of the loan of £28,900. It was stated that £21,100 had been paid over to the Electric Lighting Company, and the works were now in the possession of the Corporation. The report was adopted by the Council. At the same meeting a committee was instructed to take the necessary steps to have the Council Chamber and Municipal Offices lighted by electricity forthwith.

South Hetton.—The Haswell and South Hetton Parish Council has resolved to light the colliery village of South Hetton by electricity, a supply being taken from a pit in the district at a cost of about £300 per annum. About 20 lamps will be used. Mr. Burnett, chief engineer to the South Hetton Coal Company, will superintend the work.

Torquay.—The Council is to proceed with the electric lighting works immediately. The *Western Morning News*, of 30th ult., contained an article giving particulars of the thoroughfares where mains will be laid; also a general outline of the works and the plant which is to be put down. Specifications are prepared for the tendering, and estimates will probably be invited in a few days.

Ventnor.—The District Council has had under consideration the proposed introduction of the electric light into the town. A letter has been received from Messrs. Edmundsons, Limited, who proposed, first, that the District Council obtain a provisional order for electric light undertaking, and transfer the same to Messrs. Edmundsons, or their nominees, Messrs. Edmundsons undertaking the payment of the costs incurred by the Council in obtaining the order. Second, the transfer of the order to Messrs. Edmundsons, the Council to have power to purchase the works upon terms to be arranged, those suggested being as follows:—If at the end of seven years, the purchase price to be the capital expended, *plus* 15 per cent.; if at the end of 14 years, the price to be the capital expended, *plus* 10 per cent.; if at the end of 21 years, or at any subsequent date, to be the capital expended, *plus* 5 per cent. Third, the price to be charged for electric current not to exceed 8d. per unit, with a sliding scale reducing the charge to 7d. to large consumers; all current required by the District Council for street lighting to be at the rate of 4d. per unit.' The committee has been instructed to make a further report to the Council before any definite steps are taken.

Walsall.—The Electric Lighting Committee reported to the Council at the last meeting that the total units generated at the station during the month of July was 7,208; the total output from the main generators, 6,652; the total units from the transformers, 5,236; and the total registered on the meters, 4,306. Instructions have been given for the cable to be laid in Freer Street for a distance of 75 yards from Bridge Street, at an estimated cost of £45. An additional transformer, with the necessary connection, is to be fixed in the transformer station at St. George's Hall, at a total estimated cost of £1,000; the transformer is to be purchased from Messrs. Thomas Parker, Limited, at the price of £558, including switches. The electrical engineer is to obtain tenders for the requisite foundations for the transformer and for the new boiler at the generating station.

Warship Lighting.—H.M.S. *Talbot* is lighted throughout by electricity, about 400 16-C.P. 80-volt incandescent lamps being fitted for this purpose. Two yard-arm reflectors, each with eight 50 C.P. 80-volt incandescent lamps are provided, and in the coal bunkers 50 C.P. lamps are also fixed. The various compasses, telegraphs, and instruments on the upper deck and bridges within the chart house, conning tower, and torpedo director house, the masthead, bow, and signalling lanterns, and also the semaphores are lighted up at night with their respective incandescent lamps. Electric lanterns, moreover, can, says the *Western Mercury*, be fitted at the masthead for flashing signals, and signalling any change of the

course of the ship when at sea. There are two dynamos, each 400 amperes, 80 volts. Except on the mess deck, each lamp is controlled by a separate switch; here, however, the lights are turned on and off simultaneously.

West Ham.—Mr. J. J. Steinitz, the Council's electrical engineer, has reported upon the proposed electric light installation. He has given a list of the thoroughfares which he considers should be lighted with arc lamps, at a cost of £1,760, the total C.P. used being 105,000. The plant, to be put down at once, will be sufficient to supply 25,000 8-C.P. lamps; but later the capacity of the station would be 50,000 8-C P. The capital outlay is £50,000. The electrical engineer could have the electrical plant ready in 12 months, but the borough engineer thinks the buildings could not be finished in that time.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackburn.—Alderman W. Thompson was yesterday to move that application be made to the Local Government Board for power to borrow £10,000 for electric traction.

Mr. E. M. Lacey, C.E., who has reported to the Blackburn Corporation upon the subject of electric traction, recommends the overhead wire system, and gives particulars as to cost of providing the necessary plant at the electricity works, showing that the Corporation can make a profit on the undertaking. The charge to be made by the Corporation he fixes at 3d. per unit.

Dundalk.—Lieut.-Col. Dickenson, on behalf of the Irish Tourist Development Syndicate, has forwarded to the Town Commissioners the outline of a scheme for the improvement of Dundalk and Blackrock. It is proposed to put down a tramway through some of the principal streets of the town, and along Quay Street, adjoining the quays, and thence *viâ* Red Barns to Blackrock. This tramway would be supplied with motive power from an electric station, which would also furnish light for the town. A committee is considering the proposals of the syndicate. A special meeting is also to be held to discuss the matter.

Germany.—The Continental Company for Electrical Undertakings, of Nuremberg, is about to commence the construction of an electric tramway between Schandau and Elbe and the Lichterham Waterfall. Messrs. Siemens & Halske, of Berlin, have acquired the horse tramways in the town of Wurzburg, with the view of converting them into electric lines.

Hawaii.—The report of the Hawaiian Tramways Company just issued, contains the following paragraph:—"A change of the motive power to electricity has been under the serious consideration of the directors. A report has been furnished by an agent of the General Electric Company, of Boston, U.S.A., who visited Honolulu specially for that purpose, and estimates based on his report have been made. These estimates have been carefully gone into, and in view of the cost of a conversion, the directors cannot be justified in recommending the introduction of electricity under the existing concession held by this company. The authorities have, however, been approached, and it is hoped that certain facilities may be granted which will remove the present difficulties, and enable the company to carry out an alteration which would undoubtedly be popular in Honolulu, and, under conditions, might be of advantage to the shareholders."

Portsmouth.—The recommendation of the special committee, presided over by Alderman G. Ellis, J.P., chairman of the Electric Lighting Committee, that Parliamentary powers should be sought for by the Council to purchase the local tramlines, and afterwards re-let them to the Tramways Company, not having proved acceptable to the municipal body, the matter has been reconsidered by the committee. It was recognised that the proposed working of the lines by electricity, to be supplied from the existing station, was not objected to; but there was a strong opinion that the committee were not in possession of sufficient data upon which to ask the Council to arrive at a decision in a matter involving such a large outlay. The committee, after mature deliberation, decided to abandon the idea of going to Parliament next Session, and appointed a small committee to obtain information from other towns, in order that, later on, a comprehensive report may be presented to the Council.

U.S. Railway Combination.—All the electric railways in Jasper County, Missouri, and Cherokee County, Kansas, have been consolidated by the South-West Missouri Electric Railway Company. The combined systems have a mileage of 32 miles, and take in the towns of Carthage, Carterville, Webb City and Joplin, Mo., and Galena, Kas., covering the lead and zinc districts. Some new track will be laid.

TELEGRAPH AND TELEPHONE NOTES.

Absurd!—A committee of the St. George's Vestry recently recommended that permission be given to the National Telephone Company to lay underground mains throughout the parish at a rental of £500 per annum to the Vestry for the privilege. The company had offered one shilling per annum. Mr. Hilton opposed this extravagant charge, and advised that as the telephone had largely assisted the commercial community, the Vestry should review their proposal. He moved that the matter be referred to committee in order that a deputation might wait upon the company to consider terms. Mr. Redman argued that as the Telephone Company was prosperous it should pay a commensurate rent. The amendment was adopted. The argument (*sic*) of Mr. Redman and the recommendation of the committee were unreasonable in the extreme.

A State-owned Cable.—During the Ottawa Conference Mr. Sandford Fleming called attention to the Bahamas cable as an instance of the advantages of Government ownership in telegraph cables. The Bahamas are connected with the mainland of Florida by a cable 211 nautical miles in length, together with 6 miles of landline. The first idea was to have the work carried out by a company under a subsidy of £3,000 per annum for a period of 25 years. Fortunately it was decided to make it a Government work, and the cable was acquired for the sum of £33,311. About June, 1894, Mr. Fleming was informed by Sir Ambrose Shea, the Governor of the Bahamas that, apart from the important advantage of having this cable under the direct control of Government, even in a financial aspect, there had been a gain, as instead of paying £3,000 a year in the form of a subsidy, the charge on the colony was already reduced to £1,800, after fully providing for a sinking fund to cover renewals as well as interest on the cost and all other charges. We now gather from the annual report from the Bahamas for the year 1895, which has been just published, that the receipts from the telegraph line between Nassau and Florida, owned by the colony, have increased by 33 per cent. during the year covered by the report.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Bahia-Rio de Janeiro ...	Sept. 4th, 1896 ...	...
Penang-Medan	Sept. 7th, 1896 ...	...
Loanda-Benguela	Sept. 13th, 1896 ...	Sept. 28th, 1896.
Zanzibar-Mombassa	Sept. 23rd, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol (Mashonaland)	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Moulmein-Bangkok	Sept. 29th, 1896 ...	Sept. 29th, 1896
Florida lines interrupting communications *via* Key West to the West Indies	Sept. 29th, 1896 ...	...
Siberian lines between Radde and Kabarowka	Sept. 30th, 1896 ...	...

The Hayti Cable.—The French Cable steamer *Francois Arago*, from Hayti for Halifax, put into Philadelphia on September 14th in distress, having encountered a hurricane which had damaged the hand and steam steering gear. She had also lost the port and starboard boats and one of her quartermasters had been washed overboard.

The cable steamer *Seine*, with the New York Hayti cable on board, arrived at Halifax on September 18th from Calais for orders and coal, and to transfer part of the Hayti end of the cable to the *Francois Arago*.

The Pacific Cable Conference.—According to the *Colonies and India* the British and Colonial Cable Conference resumes its sitting again at the Colonial Office at the end of this month. During the recess Mr. Mercer, the Secretary of the Commission, has been collecting evidence as to the technical details of a feasible Imperial scheme.

Sir Richard Cartwright had a long conference with Mr. Chamberlain on the Pacific Cable and other topics at Ottawa on Monday. The *Times* says that there is a general impression that Sir Richard Cartwright will represent Canada at the Colonial Office conference on the Pacific Cable question next month.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—October 28th. The Société Nationale des Chemins de Fer Vicinaux, in Brussels, is inviting tenders for the conversion of about 23 kilometres of "Vicinal" railways in the Charleroi district, into electric lines on the overhead conductor system. Particulars may be had for 1 fr. from, and tenders to be sent to, the Société Nationale des Chemins de Fer Vicinaux, 26, Rue de la Science, Brussels.

Belgium.—October 21st. The Belgium State Railway authorities have fixed October 21st, as the last date for the receipt of tenders for the supply and erection of all the necessary plant required for a self-contained installation of electric lighting at the railway station at Arlon, for the lighting of the railway station offices, locomotive and waggon shops, locomotive shed, &c. Tenders are to be sent to the Bourse, Brussels, where particulars may be obtained.

Christiania.—The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Christiania, stating that tenders are invited for the delivery of 22,000 linear metres (13 miles 1,180 yards) of rails with the accom-

panying fish-plates and screws for the electric tram line to be constructed between Christiania and Holmenkollen. Tenders are to be sent in sealed envelopes, marked "Aubud," by October 15th, 1896, to the tramline's offices, 47, Kirkevien, Christiania, where the conditions can be procured. The rails must be delivered in Christiania by January 1st, 1897. Further particulars on the subject are expected from Her Majesty's Consul-General, and will be on view, as soon as they have arrived, at the Commercial Department of the Foreign Office.

Dundee.—October 9th. Tenders are invited for boiler, fittings, steam pump and piping, wiring, fittings, accumulator batteries, steam and oil engines and dynamos, for the electric lighting of the Dundee Royal Lunatic Asylum. Tenders to be sent to the secretary, Mr. Robert C. Walker, 5, Whitehall Street, Dundee. Particulars to be obtained on application to Mr. Walter H. Tittensor, electrical engineer, Dudhope Crescent Road, Dundee.

France.—October 8th. Tenders are invited for the supply of 137 kilometres of paper insulated electric cables in 12 lots. Tenders to be sent to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

France.—October 16th. Tenders are being invited for the supply of 50 tons of galvanised iron wire 5 mm. diameter, 100 tons of galvanised iron wire 7 mm. diameter, and 70 tons of galvanised iron wire 2½ mm. diameter. Tenders to be directed to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Madras.—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

Madrid.—October 8th. The Secretary of State for Foreign Affairs learns from her Majesty's Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez in Porto Rico. October 8th is the date fixed for the consideration of tenders, and such particulars as her Majesty's Government have received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

Madrid.—The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Charge d'Affairs at Madrid stating that a free public competition is announced in the *Gaceta de Madrid* of September 4th, for the grant of the contract of the construction and establishment of three submarine cables to join the islands of Luzon, Panay, and Negros y Cebu, in the Philippine Archipelago. Tenders must be lodged within 90 days of the publication of the conditions at the Spanish Ministry of the Colonies, accompanied by a deposit of 50,000 pesetas. The particulars received can be seen in the Commercial Department of the Foreign Office, between the hours of 11 and 6.

Morley.—October 14th. From our "Official Notices" particulars may be obtained of boilers, engines, dynamos, alternators, &c., for which the Electric Light Committee invites tenders.

Roumania.—November 16th. The Municipal Authorities of Bucharest are inviting tenders for the supply and erection of two auxiliary steam engines at the hydro-electric central station at Grozaresti. Tenders to be sent to La Mairie, Bucharest, Roumania.

Spain.—October 12th. Tenders are being invited by the Spanish Post and Telegraph authorities in Madrid for the supply of 60,000 porcelain insulators. Tenders to be addressed to the Direccion General de Correos y Telegrafos, Madrid.

CLOSED.

Italy.—The Italian Post and Telegraph authorities have placed the order for 70,000 zinc rods for primary batteries with Signor Marco Cappelli of Modena, the price agreed on being £1,212.

Prestwich.—The contract for the renewal of the Telephonic, electric signalling, and fire alarm service at the County Asylum has been let to Mr. Thomas Barton of Blackburn, who will also maintain the whole system for seven years.

St. Olaves.—The Guardians have accepted the estimate of the National Telephone Company, amounting to £55 5s. per annum, for connecting the two workhouses and the infirmary telephonically.

NOTES.

Accident.—Mr. J. Whittaker, electrical engineer, of Dudley, while superintending the laying down of an electric light installation in some new premises at Birmingham, caught his coat sleeve between the driving belt and the dynamo pulley. He is now in the Guest Hospital suffering from a dislocated forearm and injuries to the face.

Gas, Water, and Electric Lighting Companies' Directory.—Messrs. Hazell, Watson & Viney's Annual ought to be a most useful publication. Last year, in reviewing it, we pointed out a good many errors, and it is satisfactory to note that most of them have disappeared. There is, however, a good deal of revision still necessary in the electrical portion, and, perhaps, if we give the chief errors, the publishers will note them. At Bath, the system is given as Thomson-Houston arcs and Brush incandescents—high tension. We feel that such a description is lacking in lucidity, and when Birmingham is stated to have a capacity of 12,000, one naturally asks what? Blackpool, too, possesses some peculiarities in its capacity, for it is given as "capacity incandescents 500 kw. arcs 165 lamps, 10 amperes." A minor error is given under Brighton, for the municipal undertaking possesses the following: Secretary, F. J. Tillstone, Town Clerk. Cambridge, we find, employs "Parsons high tension" system, Chelmsford has a "capacity of station 220 kw. for incandescents, part overhead and part underground," Crystal Palace uses "H T continuous transformed dynamotors and accumulators," Exeter has gone in for "Morley Victoria incandescents." It is unnecessary to give many more, though Keswick, we might mention, has a capacity of 2 30 kilo Watt's machines. The arrangement and printing of the directory leave little to be desired, and if it could be purged from the serious blemishes we have noted, it would prove a most useful publication.

Trade with Spain.—Germany is making a great effort to secure trade in Spain. This remark applies particularly to the electrical business, and we have over and over again tried to make British contractors think about the matter. Our consuls in Spain are not to blame that the business does not come this way, for they are continually drawing attention to the question. The cream of electric lighting concessions would appear to be going to Germany, and this naturally means that orders for plant go the same way, and that the business is, and always will be, kept almost exclusively in German hands. Vice-Consul E. F. Johnston, of Seville, reporting to the Foreign Office on the trade of Seville for 1895, says: "It is unfortunate that British electricians have allowed Germans to secure most of the concessions for electric lighting in this country. A company was formed last year for supplying electric light for Seville, about half the capital being subscribed locally, and the rest coming from Germany. It is needless to add that all the machinery is imported from the same country, and that the business is worked by Germans." Another proof of the activity of Germany in Spain is—if the report which reaches us from a correspondent is correct—the fact that the German telegraph authorities are arranging for the erection of a direct telegraph line between Germany and Spain.

Appointments Vacant.—M. Fabius Henrion, of Nancy, requires an engineer-in-chief for his workshops, for the construction of polyphase plant. For further particulars see our advertisement columns.

The Bradford Corporation want a switchboard attendant, and one out-door assistant used to meters, arc lamps, wiring, &c. For further details see our small advertisements.

The Northampton Institute want an engineering workshop assistant, drawing office and mechanical laboratory assistant, and others. For particulars see our "Official Notices."

Two "electricians in charge" are wanted for the Huddersfield Corporation electric supply station. Further details will be found among our "Official Notices."

Gas.—A gas explosion occurred on 28th ult., at Clifton, a leak being the cause. The house and occupant were injured. There was a similar occurrence on 27th ult. at Richmond Road, Dalston, two occupants, a man and a child, being badly burnt.

Electrical Engineering in Poland.—The Actien Gesellschaft Electricität Warschau is the title of a company which has just been formed in Warsaw, with a capital of £130,000. It is stated that the Allgemeine Electricitäts Gesellschaft, of Berlin, is largely interested in the new concern.

The International Submarine Telegraph Memorial.—In addition to those whose names have already been published, the following have agreed to join the committee which is being formed for the furtherance of the above object:—

Lord Charles Beresford, C.B, R.N.; Lord Rayleigh; Sir David Salomons, Bart.; Sir Thomas Sutherland, K.C.M.G., M.P.; Sir James F. Garrick, K.C.M.G, Q.C.,; Sir Charles Todd, K.C.M.G. (Postmaster-General of South Australia); Sir Donald Currie, K.C.M.G.; Sir Alfred Dent, K.C.M.G.; Sir Julius Vogel, K.C.M.G.; Sir Roper Lethbridge, K.C.I.E; Sir A. Wilson; His Excellency Dr. von Stephan (Minister of German Posts and Telegraphs); His Excellency Ernst Daniel (Hungarian Minister of Commerce); Monsieur E. A. Floyer (Inspector-General of Government Telegraphs, Egypt); H. C. Fischer, Esq., C.M.G.; B. T. Finch, Esq.; General Eckert (U.S.A.); Charles Burt, Esq., J.P.; Colonel H. M. Hozier; Thomas McKie, Esq.; Commodore Suenson, D.R.N.; A. H. Baker, Esq. (Stock Exchange); Frank Dawes, Esq.; Alexander Elder, Esq; Herrn Emil Guilleaume; Herrn Max Guilleaume; Herrn Theodore Guilleaume; John W. Mackay (U.S.A.); Abram S. Hewitt (U.S.A.); W. Claude Johnson, Esq.; T. R. Tufnell, Esq.; W. Worby Beaumont, Esq., M.I.C.E., M.I.M.E.; H. C. Burdett, Esq.; W. H. Burman, Esq.; J. T. Crowe, Esq.; G. C. Jack, Esq.; J. Lockie, Esq. (*Steamship*); W. R. Lyne, Esq.; A. R. H. Mackay, Esq.; W. H. Maw, Esq. (*Engineering*); F. Moll, Esq.; F. C. C. Nielson, Esq.; J. Pendred, Esq.; T. H. S. Pullin, Esq., M.D., F.R.C.S.; Benjamin Smith, Esq.; W. O. Smith, Esq.; G. B. Stacey, Esq.

The *Pall Mall Gazette* says that the first meeting of the committee will be held next Tuesday at Winchester House.

Society for Promotion of Engineering Education.—The *Electrical World* (New York) publishes a list of subjects of papers read before the above society's meeting at Buffalo. There is a strong professorial flavour about the list of authors, and one is tempted to look on the whole thing as a trading affair. The whole question of technical education is on a very uncertain basis, and we know of no technical paper that has absolutely decided views on the question. Our above-named American contemporary seems to consider that students at technical schools have certain rights. The practising professor who uses a *possè* of students to make observations for him in place of paying for the work for which he is paid handsome fees, is evidently not peculiar to this country. He is abroad in America, and our contemporary, while not debarring a professor from practice, would have this right subject to very stringent regulations or restrictions. The making of tests for the practising professor is characterised as a waste of the students' time, just as much as the attempt to acquire conversation in one or more foreign languages is a waste of time. Grammatical construction and translation would be better suited to the needs of the majority, leaving conversation rather, we may suppose, to the fortunate few who are able to acquire the same by actual residence. Professors, too, ought to be capable of judging a student's qualifications, and no fear of the loss of tuition fees should deter them from counselling a student to drop engineering for some other pursuit. The tone of the article, as of the majority of all articles on technical education, is in the direction—itself a professorially indicated direction—of looking on mere ability to acquire the curriculum as evidence of future success. But is this altogether wise? Many of the best mechanics and engineers of this day, as well as of the past, are not men who could readily acquire the knowledge sought to be imparted at a college. One of the immediate results of technical education has been the raising up of a large body of men whose interest and endeavour it is to set going the maximum number of technical schools, with a view to their own enchairing as professors thereof, and the danger is that money will be frittered away on a number of second-rate institutions that would be better if spent on fewer of a higher class.

Obituary.—Mr. J. A. Warwick, whose death occurred on the 17th ult., was for 25 years Superintendent of the Telegraph Department of the Midland Railway at Derby, from which office he retired in 1878, when Mr. W. Langdon succeeded him. He was originally an officer in the employ of the old Electric and International Telegraph Company. At the time the State acquired the telegraphs, he transferred his services to the Midland Railway. Since 1878, his life has been semi-private. He was the inventor of apparatus closely allied with the block system. He was buried on 21st ult., at Derby. Mr. Warwick was 75 years of age at his decease.

A Curious Statement.—Mr. R. F. Sunderland, who falls foul of a lecturer in the *Halifax Courier*, is liable to be misunderstood. He says: "The gratuitous information given to your readers about German lamps, and putting of work in the hands of responsible and respectable firms is, I consider, a direct insult to the local electrical contractors." Why, surely there are responsible and respectable firms among the local ones. If we remember rightly, Mr. Sunderland is at the head of a local firm of electrical engineers who are eminently reputable.

Electric Lighting on the "Fram."—The daily press publishes some particulars regarding the use of electricity on the *Fram*. According to this article the electric light gave great satisfaction, and general regret was expressed when in May, 1895, Lieutenant Sverdrup and Mr. Nordahl decided that it must be dispensed with, owing partly to the wearing out of the gearing of the cog-wheel in the windmill which worked the dynamo, after the vessel had entered the ice, and partly to the fact that portions of the apparatus were required for making snowshoes and runners. Mr. Nordahl took advantage of every puff of wind to load the accumulators, so that they were kept continually charged, and until May last year the electric light was always available. In the severe cold the accumulators froze right through, but the acid-blended ice proved an excellent electrolyte, and the frost did not interfere with the working of the accumulators. On festive occasions Nordahl suspended an arc lamp in the saloon, which gave such an excellent light that Dr. Nansen frequently used it when painting or photographing, although of course such luxurious illumination could not be afforded for every-day use. On the evening before Dr. Nansen and Lieutenant Johansen left the *Fram* on their northern journey, Mr. Nordahl, with the incandescent lamp in a garland of paper flowers, improvised an illuminated transparency bearing the words God Tur! (a safe journey.) When the two explorers left the ship, the arc lamp was run up to the top of the mainmast as a farewell greeting. The rigging was so thickly coated with ice that it had to be broken to pieces before the lamp could be fastened to the ratlins. Electricity was also used for other purposes besides lighting, the mining shots which set the *Fram* free from the grip of the ice being fired by means of a cable attached to six Leclanché cells. In brief, the entire electric installation worked admirably, and Mr. Nordahl praised it in every respect.

Fluorescence of Sodium and Potassium Vapours.—E. Wiedemann and G. C. Schmidt have been investigating the fluorescence of sodium and potassium vapour, and find that it is very marked, the sodium being green and the potassium red. The spectra which these vapours yield under the influence of electrical discharges appear to correspond to the fluorescence spectra, and it is pointed out that Stokes's rule holds for these as for other cases of fluorescence. It is suggested, in the conclusion of the paper, that the establishment of fluorescence for the vapours of the metals would throw light on some hitherto unexplained astrophysical phenomena. The original paper may be found in the *Annalen der Physik und Chemie*, 1896 (2), 57, 447.

Terrestrial Magnetism.—In his paper on the distribution and the secular variation of terrestrial magnetism, L. A. Bauer states that part of the earth's permanent magnetism which is symmetrical about the earth's rotation axis is separated from that which is unsymmetrical. The unsymmetrical part is resolved into two fields, one of which can be referred to a homogenous magnetisation about a diameter lying in the equatorial plane, and the other, a complex one, called the residual field. An abstract in a trans-Atlantic change attributes to the author the statement that the magnetic field resulting from the combination of the symmetrical field with the homogeneous equatorial field will represent at least 70 per cent. of the earth's total field. This combined or resultant field, termed in brief the homogeneous magnetisation field, has been adopted as the so-called normal magnetic field. Whatever is left of the earth's total field, after deducting this normal field, constitutes the residual field referred to above. Some interesting and important deductions were made. Thus, for example, it was shown that the residual field has characteristics precisely analogous to those of the diurnal variation field. It differs thus radically from the homogeneous field.

The Telegraph Memorial.—We understand that a circular has been issued, inviting shareholders in the Anglo-American Telegraph Company to subscribe towards this memorial. The *Investors Guardian* remarks that the "circular states that although it is too early to forecast the precise form the memorial will take, there will probably be a statuary design, the balance of the fund being devoted to an appropriate object, to be decided upon later, connected with technical education."

Lectures.—Next Monday, Dr. Fison commences, at the Canning Town Public Hall, a course of ten free lectures on "Electricity, and its Modern Applications."

The courses of evening lectures in electrical subjects, for the winter, at the Finsbury Technical College, are announced to open on Monday, October 5th. For the Wednesday evening (first year) course, the topics of the lectures before Christmas are practical electrical measurement and magnetism. For the Monday evenings (advanced) the construction and theory of dynamos and alternators are announced. The lecture next Monday evening will be by Prof. Silvanus Thompson, on "The Production of special qualities of Iron and Steel for Dynamos and Alternators." Mr. F. R. Flew takes the Physics lectures on Friday evenings.

The Students' Tour in Switzerland.—A small party of students of the Institution of Electrical Engineers has recently returned from a 10 days' tour in Switzerland, where they visited a number of places of electrical interest. The party left London on August 29th. The Bâle electric tramway was inspected, also the Falls of the Rhine at Neuhausen, the wire-rope and electric power transmissions at Schaffhausen, Sulzer Bros. large engine works at Winterthur, the Zürich central station, and the two Zürich electric tramway stations. Very interesting visits were also made to the works of Messrs. Brown, Boveri & Co., the Maschinenfabrik Oerlikon, and Escher, Wyss & Co. The party also saw the installation at the Tonhalle, where a battery of accumulators is charged during the daytime off the alternating supply mains by means of a motor generator, and is used for lighting the concert hall by night. A Pollak rectifier was formerly used for this work, but was found to spark too much. The Dolder cable railway, worked by an electric motor off a private lighting plant, was also visited. The Stanserton cable mountain railway, which is driven by electric motors, the electric power being transmitted from a water-power station near the foot, was ascended. At Berne the Mekarski compressed air tramway was inspected. At Geneva the National Exhibition, the works of the Cie de l'Industrie Electrique (système Thury), the Mont Salève electric rack railway, and the electric light stations, including the new water-power two-phase station at Chèvres, on the Rhone, where 18,000 H.P. is eventually to be utilised, were also seen.

Personal.—Mr. Thomas Tomlinson, B.E., is now in Killarney for the purpose of reporting upon extensions to be made to the electric light generating plant at that town.

Exhibition.—Arrangements are already in hand for the Hardware, Machinery, Ironmongery, Inventions, Electrical, and Allied Trades' International Exhibition and Market, to be held at the Royal Agricultural Hall from August 2nd to 9th, 1897. Mr. W. E. Aylwin is the managing director, and Mr. H. S. Rogers the secretary. Communications *re* space to be sent to 27, Leadenhall Street, E.C.

English Gold and American Companies.—According to the *Western Electrician*, a financial deal of importance that has just been consummated indicates that the political situation has not destroyed the faith of foreign investors in American securities. This is the sale of $1,200,000 worth of 5 per cent. gold thirty-year bonds of the Chicago Edison Company to a London financial syndicate. The proceeds of the sale will be paid in gold, and will be used to extend the plant.

New Company.—The business of Messrs. New & Mayne, electrical and general engineers, of Westminster and Woking, has been formed into a limited liability company—New and Mayne, Limited—with a capital of £150,000.

Scholarship.—The Huxley Scholarship of £60 for three years, tenable at the Central Institution, has been awarded to Mr. John Muir Donaldson. Mr. Donaldson recently passed through the electrical engineering course at Finsbury Technical College with credit, and was formerly under the tuition of Mr. W. Perren Maycock, M.I.E.E.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Otis Elevator Company, Limited (38,450).—This company's annual return was filed on August 4th. The capital is £50,000 in £10 shares, and 2,000 of these have been taken up; 650 have been considered as paid, and £13,500 has been called and paid on the rest.

P. R. Jackson & Co., Limited (35,232).—This company's annual return has just been filed. The capital is £120,000, in £10 shares (of which 6,000 are preference); 5,392 preference and 5,041 ordinary have been taken up, and £65,000 has been considered as paid on 7,400 shares. Certain calls have been made on the others, and £21,231 has been paid. No distinction is made between the fully and partly paid shares.

Phonopore Company, Limited (25,480).—This company's annual return was filed on July 9th. The capital is £150,000, in £1 shares (of which 50,000 are preference); 90,000 ordinary and 28,343 preference have been taken up, and 69,025 ordinary and 10,380 preference are considered as paid. £1 per share has been called on the others, and £38,791 15s. has been paid, leaving £146 5s. in arrears.

CITY NOTES.

Brush Electrical Engineering Company, Limited.

The report of the directors of the Brush Electrical Engineering Company, Limited, for the year ended June 30th last, to be presented to the general meeting to be held at the Cannon Street Hotel, E.C., on October 5th, states that the profit and loss account shows a gross profit of £33,736. After deducting general charges, maintenance of buildings, plant, and patents, staff bonuses under the company's profit-sharing scheme, bank interest, and interest on first and second debenture stock, there remains a net balance of profit for the year of £4,615. The directors regret that the profits for the year are not larger. The result is attributable partly to a general falling off in the volume of central station electricity supply contracts, and partly to the prevalence of unduly low prices for electrical machinery. The directors anticipate, however, that the future demand for electric traction plant will fully compensate for the shrinkage of orders for electric lighting machinery, while with regard to prices they are glad to state that there are some indications of improvement. Meanwhile every effort has been made to minimise general and administrative charges, there having been the substantial reduction of nearly £4,000, which has been effected during the year. The directors anticipate still further reductions during the current year. During the past year the directors have accepted an offer from one of the large Continental manufacturing firms for the purchase of the Vienna factory. The amount realised fully reimburses the company for its capital outlay on the business, and the sum resulting from the transaction, which was upon a cash basis, appears under the items relating to cash in the balance-sheet. In deference to the wish expressed by shareholders at recent annual general meetings, and, in view of the disposal during the year of the company's Vienna factory, the directors consider the present a convenient opportunity for sub-dividing the capital item of property, patents, and goodwill, which has hitherto appeared as a single item in the balance-sheets. With this object they have obtained a full report from Messrs. Fuller, Horsey, Sons and Cassell, whose valuation of the company's freehold works, together with the fixed plant, machinery, loose tools and utensils, at Loughborough, Leicestershire, amounts to £83,847, and of the leasehold factories at Lambeth and Southwark to £5,000, together value £88,847. Deducting this sum from the amount of £295,244, representing the aggregate value of the undivided items of property, patents, and goodwill, it will be seen that a balance of £206,397 is represented by patents and goodwill. While many valuable patents owned by the company are still included in the item of patents, the early patents in connection with electric lighting, for which large sums were originally paid by the company, have now mostly expired. In order to deal effectively with the position thus arising, the directors strongly recommend the shareholders to write off £1 per share from the nominal value of the ordinary shares of the company. This will produce a figure of £90,000, which it is proposed to apply during the current year to reduction of the item of patents and goodwill, and to eliminating from the books such of the items included in the suspense account appearing in the balance-sheet as may prove to be valueless. The directors have placed to this suspense account all assets standing in the books of the company which they consider to be in any way doubtful; and the step now recommended, upon receiving the sanction of the shareholders, will ensure that profits of future years shall not be hampered by the uncertainty attached to the doubtful assets referred to. A resolution to carry out this recom-

mendation will be submitted to an extraordinary general meeting, to be held at the close of the ordinary meeting. Subject to this recommendation being adopted by the shareholders, the directors propose to pay to the preference shareholders the balance of dividend due to them from last year, amounting to £2,141, and to carry forward the balance of £1,654 which remains after clearing off the debit of £820 brought forward from last year. In accordance with the shareholders' approval at the last annual general meeting of the decision to create an issue of £105,000 4½ per cent. redeemable second debenture stock, £76,770 of such stock was allotted in the autumn of last year. During the year under review the company have sub-leased the Lambeth factory for the remainder of their term; and have transferred the final remnant of their London manufacturing operations to Loughborough, where the whole of the company's manufacturing is now concentrated. An important contract has been secured from the British Electric Traction Company for the equipment of the North Staffordshire Tramways system with electric traction. There is every indication that electric traction will be largely adopted in this country in the immediate future, and the position of the company in regard to the undertaking of works of this character is exceptionally favourable, having regard to their command of ample working capital, and to the fact of their being manufacturers of rolling stock and tramway material, as well as of electrical plant. The contracts with the County of London and Brush Provincial Electrical Lighting Company for the equipment of electricity supply stations in St. Luke's, Middlesex, and the Wandsworth district, have been in progress during the year, and it is expected that a supply of current will be available in both areas during the coming winter. The contract with the Government of Malta for the establishment of an electricity supply station for the lighting of Valetta and of the Government establishments is now practically completed, and the result has given general satisfaction. During the year the "Universal" steam engine, to which the attention of shareholders was drawn last year, has been developed, tested, and placed upon the market. Orders are in course of execution for central electricity supply stations, factories, mining works, &c. The company are introducing a type of alternating current dynamo, new to this country, for which they hold important patent rights. This dynamo possesses valuable features, which the directors believe are likely to command for it a ready sale.

Balance-Sheet, June 30th, 1896.

Dr.	£ s. d.	£ s. d.
To Authorised capital	750,000 0 0	
„ Capital issued, viz :—		
90,000 6 per cent. preference shares of £2 each	180,000 0 0	
90,000 ordinary shares of £3 each	270,000 0 0	
		450,000 0 0
„ 4½ per cent. perpetual first debenture stock, secured by debentures charged on the undertaking		125,000 0 0
„ 4½ per cent. redeemable second debenture stock, part of £105,000 secured by debentures charged on the undertaking		76,770 0 0
To Creditors—		
Sundry creditors—		
Head office ... £28,460 5 0		
Australian branch at April 30th, 1896... ... 522 11 2		
	28,982 16 2	
Bills payable—		
Head office ... 4,502 18 0		
Australian branch at April 30th, 1896... ... 100 0 0		
	4,602 18 0	
		33,585 14 2
To Loan from bankers (against security)		26,775 0 0
„ Profit and loss account—		
Balance of profit and loss account, subject to realising the whole of the suspense account, *per contra*	4,615 9 8	
Less balance as per last account ...	820 7 4	
		3,795 2 4
Note.—Contingent liability in respect of uncalled capital on shares in other companies..	£11,142 10 0	
		£715,925 16 6

Cr	£ s. d.	£ s. d.
By Property—		
Freehold and leasehold factories at Loughborough, Lambeth, and Southwark, including plant and machinery, as per valuation of Messrs. Fuller, Horsey, Sons and Cassell	88,847 0 0	
By Patents and goodwill (balance of property, patents, and goodwill account)	206,397 8 9	
Carried forward		295,244 8 9
Brought forward		£295,244 8 9
By Stock—		
Goods in hand, in process of manufacture, work in progress and materials in London, at Loughborough and other places	110,164 16 7	
Australian branch at April 30th, 1896	13,866 11 7	
	124,031 8 2	
Less amounts transferred to Suspense Account	23,368 11 9	
		100,662 16 5
By Debtors—		
Sundry accounts:—		
Head office	134,766 6 9	
Australian branch at April 30th, 1896	4,169 12 6	
Australian branch, balance of items in transit and invoices rendered, less cash received from April 30th to June 30th, 1896	1,497 8 5	
	140,433 7 8	
Less amounts transferred to Suspense Account	24,158 6 2	
	116,275 1 6	
Bills receivable:—		
Head office ... 1,210 19 10		
Australian branch at April 30th, 1896 ... ... 24 14 0		
	1,235 13 10	
		117,510 15 4
By Cash at bankers, in hand, and instalment on account of sale of Vienna factory, payable July 15th, 1896:—		
Head office	28,315 4 6	
Australian branch at April 30th, 1896	398 16 3	
		28,714 0 9
By Balance on account of sale of Vienna factory, payable October 1st, 1896		61,900 0 9
By Shares and debentures in other companies at cost...	64,366 16 7	
Less amounts transferred to Suspense Account	7,912 10 0	
		56,454 6 7
By Suspense Account, consisting of amounts transferred from stock, debtors, and shares and debentures in other companies:—		
Transferred from stock ...	23,368 11 9	
Transferred from debtors ...	24,158 6 2	
Transferred from shares and debentures in other companies...	7,912 10 0	
		55,439 7 11
		£715,925 16 6

We have examined the above balance-sheet with the books, accounts, and vouchers of the company, and, in our opinion, subject to the following remarks, it is properly drawn up so as to exhibit a correct view of the company's affairs on June 30th, 1896. We have verified the cash balances, and the shares and debentures in other companies. The latter are considered by the board to be of the full value stated in the accounts, but, as to part of them, we are not able to verify the market value. It will be noticed from the directors' report that the assets transferred to the Suspense Account are considered doubtful, and we have not means of ascertaining their value. We have also verified the securities held by the trustees of the employés' bonus scheme.

Cooper Brothers & Co., *Chartered Accountants*, } *Auditors.*

London, *September 25th*, 1896.

Appropriation Account.

(Subject to adoption by the shareholders of the recommendation of the directors to reduce the nominal value of the ordinary shares by £1 per share.)

Dr.	£ s. d.
To Balance of dividend due to preference shareholders for year ended June 30th, 1895	2,141 3 8
„ Balance carried forward	1,653 18 8
	£3,795 2 4

Cr.	£ s. d.
By Balance	3,795 2 4
	£3,795 2 4

PROFIT AND LOSS ACCOUNT for the year ended June 30th, 1896.

Dr.	£ s. d.	£ s. d.
To General charges, viz.:—		
Directors' fees	1,000 0 0	
Auditors' fee	105 0 0	
Salaries	6,795 18 11	
Law charges	175 16 1	
Insurance	483 15 10	
Postage, stationery, and printing	912 2 11	
Rent, rates, and taxes	1,963 11 11	
Advertising and London office expenses	1,680 12 0	
		13,116 17 8
„ Further cost of removal to Loughborough ...		942 1 2
„ *Maintenance of buildings and plant		3,048 15 9
„ Maintenance of patents		139 8 9
„ Bank interest and commission		2,042 1 5
„ Interest on first debenture stock to June 30th, 1896		5,625 0 0
„ Interest on second debenture stock to June 30th, 1896		2,590 19 9
„ Staff bonuses for year ended June 30th, 1895 ...		540 0 0
„ Income-tax		577 1 7
„ Bad debts		498 11 2
„ Balance, profit carried to balance-sheet		4,615 9 8
		£33,736 6 11

* I hereby certify that the buildings and plant of the company under my supervision have been maintained in an efficient condition during the year ended June 30th, 1896. JOHN S. RAWORTH, *Chief Engineer.*

Cr.	£ s. d.
By Gross profit (including the profit realised on sale of Vienna business)	33,298 4 0
„ Dividends on securities held	330 4 11
„ Transfer fees	107 18 0
	£33,736 6 11

TRUSTEES' CASH ACCOUNT in connection with the Employés Bonus Scheme, under Trust Deed dated January 10th, 1894, for the year ended June 30th, 1896.

Receipts.	£ s. d.
To Cash in hands of trustees, and accrued interest as per last account	50 17 4
„ Cash received by trustees from Brush Electrical Engineering Company, Limited, being bonus for year ended June 30th, 1895, as per profit and loss account	540 0 0
„ Dividends on investments, and estimate to June 30th, 1896	56 16 0
„ Sale of a portion of the trustees' investments, the proceeds being placed in bank to credit of the trustees' current account	150 0 0
	£797 13 4

Expenditure.	£ s. d.
By Bonuses paid to employés or deposited in savings banks on their account during the year	474 5 8
„ Cash paid for £208 5s. 8d. New South Wales 3 per cent. inscribed stock, to form part of the provident and reserve fund provided for by the scheme, and invested in the names of the trustees	199 8 7
„ Stationery, printing, and other expenses	0 15 8
„ Cash in hands of trustees and accrued interest ...	123 3 5
Note.—The provident and reserve fund is now composed of the following securities:— £800 Pennsylvania R. R. 3½ per cent. Consolidated Bonds. £800 Cape of Good Hope 3½ per cent. Consolidated Inscribed Stock. £949 8s. 6d. New South Wales 3 per cent. Inscribed Stock.	
	£797 13 4

Notice is given that immediately after the termination of the seventh annual general meeting of the Brush Electrical Engineering Company, Limited, to be held at Cannon Street Hotel, London, E.C., on October 5th, 1896, at 12 o'clock, noon, an extraordinary general meeting of the company will be held at the same place for the purpose of considering, and if thought fit, of passing the following resolution, namely:—

"That the capital of the company be reduced from £750,000, divided into 150,000 preference shares of £2 each (of which 90,000 have been issued), and 150,000 ordinary shares of £3 each (of which 90,000 have been issued), to 660,000, divided into 150,000 preference shares of £2 each, and 180,000 ordinary shares of £2 each, and that such reduction and alteration be effected by cancelling paid-up capital to the extent of £1 per share on each of the 90,000 ordinary shares which have been issued, and by reducing the nominal amount of the said 90,000 ordinary shares from £3 to £2 each, and by subdividing the 60,000 ordinary shares of £3 each, now remaining unissued, into 90,000 ordinary shares of £2 each."

In the event of the above resolution being passed by the requisite majority, it will be submitted for confirmation as a special resolution at an extraordinary general meeting of the company to be subsequently convened.

Willans & Robinson, Limited.

THE fifth half-yearly report of the directors, to be submitted at the ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, London, at 3 p.m., on Wednesday, October 7th, 1896, states that, after writing off as depreciation from plant, patents, &c., the sum of £4,039 14s. 7d., and paying a small amount of interest accrued upon the recently issued debenture stock, the balance to the credit of profit and loss account for the half-year (including £821 5s. 3d. brought forward) is £12,876 12s. 4d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum, as before, upon the ordinary shares, together amounting to £7,312 10s. The amount payable to the directors, in accordance with the articles of association, is £1,422 17s., and it is proposed to carry £2,500 to the reserve fund, raising the amount to £10,146 9s. 11d. as the result of 2½ years' working. The balance, £1,641 5s. 4d., it is proposed to carry forward. The debenture stock authorised to be created by the resolution passed at the last general meeting was issued in May, at par, the rate of interest being 4½ per cent. per annum, and was largely over-subscribed. The directors were advised to fix the issue at £100,000, rather than at the smaller amount they had in view at the date of the last meeting. The growth of the business in the present year leaves no doubt that the larger amount can be utilised with advantage. The expenses connected with the above issue amounted to £1,151 8s. 2d., which sum appears on the present occasion as a credit in the balance-sheet. As the debenture stock is repayable after a term of years, it would be proper to write off the expenses by a small half-yearly charge extending over the same term, but it will probably be felt that so small a sum ought to be dealt with immediately, as, for instance, by writing it off at once out of the balance to be carried forward in the profit and loss account. To this it may be objected that the balance in question is surplus profit, and, therefore, has already contributed to the contingent salaries of the directors and staff, whereas, strictly, the cost of the debenture issue is in the nature of an expense, which should reduce the surplus profits, and, therefore, the contingent salaries. If, on the other hand, the amount is written off at once, and the contingent salaries are reduced in proportion, it will fall somewhat hardly upon the present holders of office, who will bear a charge which ought partly to fall upon their successors. It is not urgent that the question be settled upon the present occasion, and as the directors' own interests are involved, they trust to receive some expression of opinion on the part of the shareholders, as a basis for action to be taken next half-year. The company's shares were granted a quotation by the Committee of the Stock Exchange last May, and a quotation of the debenture stock (provisional certificates) has since been given. The works of the company continue to be very fully employed; in fact, orders are in hand for a long period in advance. Work will shortly be commenced in the new shops at Rugby.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to appoint a special settling-day in and to grant a quotation to—Aluminium Company, Limited—£90,000 4½ per cent. first mortgage debenture stock, in lieu of the 6 per cent. debentures now quoted. Charing Cross and Strand Electricity Supply Corporation, Limited—10,000 4½ per cent. preference shares.

The Committee has ordered the following to be quoted in the Official List:—Metropolitan Electric Supply Company, Limited—12,500 ordinary shares, Nos. 50,001 to 62,500.

Postal Telegraph Cable Company.—The directors of the Postal Telegraph Cable Company, 253, Broadway, New York, announce a quarterly dividend of 1 per cent. on the capital stock. The transfer books will be closed from 5th to 18th inst, inclusive.

Metropolitan Electric Supply Company, Limited.—The directors have declared an interim dividend of 4s. per share for the half-year ended June 30th. The transfer registers will be closed from 3rd to 10th insts., inclusive.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended June 30th last of 2s. 6d. per share, free of income-tax.

Reuter's Telegram Company, Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum, free of income-tax, for the half-year ended June 30th last.

Evered & Co., Limited.—The directors of Evered & Co., Limited, have resolved to pay an interim dividend at the rate of 7½ per cent. per annum for the half-year ended June 30th.

Hove Electric Lighting Company, Limited.—The directors have declared an interim dividend for the half-year to June 30th last at the rate of 4 per cent. per annum.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 27th, 1896, were £925; week ending September 29th, 1895, £823; increase, £102; total receipts for half-year, 1896, £11,813; corresponding period, 1895, £10,971; increase, £842.

The Liverpool Overhead Railway Company. The receipts for the week ending September 27th, 1896, amounted to £1,168; corresponding week last year, £1,266; decrease, £98.

The Western and Brazilian Telegraph Company, Limited. The receipts for the weeks ending September 4th, 11th, and 18th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,589, £1,588, £1,810.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Sept. 23rd.	Closing Quotation, Sept. 30th.	Business done during week ended Sept. 30th, 1896. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	50 — 53	49 — 52	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	95½ — 96½	95 — 96	95⅞	94
2,993,560£	Do. do. Defd.	Stock	...	...	...	8¾ - 9¼	8¾ - 9¼	9	8 13/16
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	15 — 15½	14¾ - 15½	15¼	14¾
75,000£	Do. do. 5 %, Debs., 2nd series, 1906 ...	100	5 %	5 %	5 %	112 - 116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	.. §	2½%	4 %	3¼ - 3⅜	3¼ — 3⅜	...	...
16,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	165 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	1¼%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ - 13½	12 — 13	12⅝	12⅜
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ - 21½	20½ - 21½	21	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110%	107 —110 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	2¼%	9¼— 9⅜	9⅜ — 10	9 5/16	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	6½%	18 — 18½	17¾ — 18¼	18⅛	17⅞
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	18½ — 19½	18½ - 19½	19¼	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	131 —134	130 —133	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18 — 18½	17⅜ — 18¼	18⅛	17⅜
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 —104	100 - 104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	130 —133	130 —133	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	101 —105	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114 %	111 —114 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	4½%	10¾ — 11¼	10¾ — 11¼	11 3/16	10⅞
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	17¾ — 18¼	17¾ — 18¼	18	17⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	24 — 25	23½— 24½	24½	24
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	107	104⅜
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 56	51 — 54	52⅜	52
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	7½— 7⅝	7⅜ - 7⅝	7⅝	7½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅞— 7⅛	6⅞— 7⅛	...	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	107 —110	107 —110	107	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4½%	5 %	⅞— ⅞	⅞— ⅞	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 — 111	108 —111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	7 — 8	7 — 8	7¾	7 1/16
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3½— 4	3½ — 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	5 — 6	5 — 6	...	...
238,380£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	½ - 1½	½ - 1½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	99 —104	99 - 104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	8⅝— 9½	8½ — 9	8⅝	8⅝
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6⅝— 7½	6½— 7	6 13/16	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2¼— 2⅝	2¼— 2⅜	2½	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	⅛%	⅞%	1⅜ - 1⅝	1¼ - 1½	1⅜	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½ - 12	11½— 12	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½ — 10½	9½ — 10½	9⅝	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —105	100 —105 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	9½— 10	9½— 10	10	9⅝
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7½— 8	7½— 8	7⅞	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	114 —117	114 —117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	16 — 17	16 — 17	16⅞	16 7/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ - 18½	17½ — 18½	18⅛	17½
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —135	131 —135	...	...
22,475	County of London and Brush Prov. Elec. Lightg., Ltd., Ord. 1—22,475	10	...	...	*nil*	8 — 9	8 — 9	8⅞	...
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13⅜ — 14¼	13⅜— 14¼	...	...
10,000	Do. do. do. iss. at 2 pm., all paid ...	10	...	...	...	5½— 6½	5½— 6½	6½	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	2½%	3 %	4 %	12½ — 13½	12½ - 13½	13 3/16	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —123	120 —123	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	11½ — 12½	11½ — 12½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	11½— 12½	11½— 12½	11 15/16	11⅞
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10½	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	4 %	5 %	7 %	11 - 12	10 — 11	10⅜	10⅛

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Sept. 23rd.	Closing Quotation Sept. 30th.	Business done during week ended Sept. 30th, 1896. Highest	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 %	2½%	...	1 — 1¼	¾ — 1	¾	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	3 %	...	1½ — 1⅝	1⅛ — 1⅜	1⅜	1 3/16
125,000	Do. do. 4½ % Perp. Deb Stock.... ...	Stock	4½%	4½%	...	110 —113	110 —113	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	97 — 101	97 —101	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	10¼ — 10⅜	10¼ — 10⅜	...	...
207,649	Do. do. do. £4 paid	10	...	...	...	4⅛ — 4⅜	4⅛ — 4⅜	...	...
630,000	City and South London Railway	Stock	1 1/16%	1⅛%	1 1/16%	49 — 51	48 — 50	50	49
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %	*nil*	*nil*	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1¾ — 2¼	1¾ — 2¼	...	...
17,139¶	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1½ — 1⅝	1½ — 1⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2½ — 3	2½ — 3	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅝ — ¾	⅝ — ¾	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝ — ¾	⅝ — ¾	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10⅛%	10½ — 11½	10½ — 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	18 — 19	18 — 19	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	22 — 23	22 — 23	22⅜	22
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	107 —110	105 —108xd	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13 7/16 — 13 9/16	13 7/16 — 13 9/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅞ — 17⅜xd	16⅞ — 17⅜	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	40 — 43	40 — 43	42	40¾
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8¼ — 8⅜	8 — 8½	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§ 1890—5%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 £4 paid), 6.
Electric Construction Corporation, 6 % Debentures, 104—107.
House-to-House Company (£5 paid), 3¾—4¼.
Do. do. 7 % Preference, of £5, 8¾ - 9¼.
Do. do. 4½% Debentures of £100, 109 - 112.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9½—10; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅜.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7⅛—8.

* From Birmingham Share List.

Bank rate of discount 2½ per cent. (September 10th 1896).

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, LIVERPOOL, 1896.

REOSTENE. A NEW RESISTANCE METAL.

By Dr. Harker and Mr. A. Davidson.

(*Paper read before Section A, September 19th.*)

Dr. Harker, of Owen's College, Manchester, described some experiments made by Mr. A. Davidson and himself on a new alloy for commercial electrical resistances, which has been called "reostene." This alloy is the outcome of a number of experiments made with a view to find a material of a higher specific resistance than iron, capable of carrying heavy currents, and having only a moderate temperature coefficient.

The average specific resistance of the material, as determined from a number of samples, is about 45—46 in terms of copper as unity, and in the specimens examined, which included strip and wire of various diameter down to No. 22 S.W.G., seems to be independent of the size of the wire.

The temperature coefficient of the wire was also determined for a number of samples. For these tests the wire was placed in an apparatus consisting of a cylindrical vessel holding about five litres of an insulated oil, which could be very rapidly stirred by means of a small double screw, placed in a side tube. This acted like a centrifugal pump, removing liquid very rapidly from below, and pouring it back on to the surface. The stirrer was actuated by a small Cuttriss motor placed on an adjustible stand, being coupled to the motor shaft by a piece of stout India-rubber tubing. The liquid could be heated either by means of steam blown through a spiral coil at the bottom of the vessel, or by a current passed through a German silver wire, wound on a frame immersed in the liquid.

A number of specimens of wire of different diameters were examined in this apparatus, and gave almost exactly the same temperature coefficient ·0011 per ohm per degree Centigrade. This coefficient remains almost absolutely constant within the limits attainable in this apparatus, 0°—60°. Experiments made with wires in a small furnace at temperatures up to 500° C. showed a slight falling off in the coefficient above 100°.

The effect of current on the resistance of the wire was also tested. For this purpose pieces of the wire of 1 or ·1 ohm resistance were fastened by hard solder to copper rings, which, by means of screws, could be attached to very stout copper leads and immersed in the bath previously described. Their resistance could be measured at a definite temperature, and they could then be removed, subjected to the treatment desired, and remeasured *at the same temperature under the same conditions.*

For all the resistance measurements a Carey-Foster bridge, designed by one of the authors for platinum thermometry, and recently described in a communication to the Royal Society, was used, and in the opposite arm to the coil was placed a Reichsanstalt manganin standard of negligible temperature coefficient. The resistance measurements were made to an accuracy considerably exceeding anything needed for the purpose of the tests, the last significant figure determined being omitted in the results given.

On treating various specimens of the wire with comparatively large currents, only an extremely small variation was found in the permanent resistance. The first effect of the current is slightly to diminish the resistance of the wire, which on longer continued action gradually rose to somewhat above its original value. Selecting at random a specimen case, a coil of No. 14 S.W.G., after a current of 25 amperes had been passed for five minutes, decreased 1 per cent., but after the current had been again passed for four hours, during which time this wire was hot enough to char paper or wood, the resistance had increased to ·09 per cent. above its original value. Similar changes were observed in coils, which had been kept for some days in the circuit of a motor, subjected to varying loads.

Only in the case of fine wires which had been heated to a full red heat could any serious change due to current be detected. Oxidation does not occur to any sensible extent below about 250° C.

The material seems soft, and will stand a considerable amount of twisting force without injury or appreciable permanent alteration in resistance. Its mechanical properties seem only very slightly influenced by the passage of current, specimens of new wire and wire subjected to high currents, showing almost exactly the same stretch for loads of ½ to ⅔ the maximum carried by the wire.

A few tests made on the alteration in resistance of the material, when embedded in a fireproof cement and carrying large currents, also gave satisfactory results, showing that when protected from oxidation the resistance is scarcely altered by exposure to a red heat.

The alloy can be brazed with ease, and can be soldered with ordinary solder. If special cleanliness is observed a fresh chloride of zinc is used.

The wire can be obtained from the makers, Messrs. W. T. Glover & Co., of Salford.

ELECTRIC GLOW LAMP TESTS.

By William Henry Preece., C.B, F.R.S., &c.

(Read before Section G, on Monday, September 21st)

(Concluded from page 396)

The following table (1) gives full particulars of the average breaking voltage of lamps supplied by some of the firms before-mentioned. It also shews the average current, resistance (hot), time of running up, and the difference in volts, amperes, watts, and the resistance (hot) between the normal requirements of the particular lamps and their breaking voltage. The four mean factors alluded to at breaking point are diagrammatically represented after the table of results. A suitable gearing controlled the motion of a falling electrode of copper, as it gradually dropped through a column of very weak dilute sulphuric acid, which, on a 350 volt circuit, allowed the pressure of the lamp to be slowly raised to the breaking point. One assistant noted the volts and manipulated a chronograph, while another recorded the current at moment of collapse. Several lamps of like voltage and candle-power were obtained from various firms, and had their filaments broken in this manner. The average breaking voltage of the filaments was found to be 230.

TABLE 1.

BEHAVIOUR OF 105 VOLT 16 C.P. LAMPS

On running up to Breakage Voltage.

Maker.	At starting.				At breaking.				Difference between starting and breaking.										Remarks.
				Resistance.					Volts.		Amperes.		Watts.		Resistance. Hot.				
	Volts.	Amps.	Watts.	Cold.	Hot.	Volts.	Amps.	Resistance. Hot.	Time of running up.	Actual.	Per cent.	Actual	Per cent.	Actual.	Per cent.	Actual. +	Actual. −	Per cent. +	Per cent. −	
									mins. secs.										
Edison Swan ..	105	·61	64·04	..	172·1	231	1·35	171·1	4 20	126	120	·74	121	247·81	387	..	1·0	..	·58	Supplied, April, 1895.
	105	·54	56·69	..	194·4	210	1·27	165·3	4 10	105	100	·73	135	210·01	370	..	29·1	..	15·0	
	105	·56	58·79	..	187·5	255	1·41	180·8	4 20	150	143	·85	152	300·71	511	..	6·7	..	3·5	
	105	·51	53·54	..	205·8	255	1·32	193·2	4 30	150	143	·81	159	283·06	529	..	12·6	..	6·1	
	105	·57	59·85	..	184·2	235	1·34	175·3	4 5	130	124	·77	135	255·10	426	..	8·9	..	4·8	
	105	·54	56·69	..	194·4	238	1·33	178·9	4 0	133	127	·79	146	259·81	458	..	15·5	..	7·9	
				Average		237	1·34	177·4	4 14											
General Electric	105	·69	72·45	..	152·2	225	1·59	141·5	4 0	120	114	·90	130	285·30	394	..	10·7	..	·58	Supplied, May, 1895.
	105	·65	68·25	..	161·5	234	1·50	156·0	3 50	129	117	·85	131	282·75	414	..	5·5	..	3·4	
	105	·66	69·30	..	159·0	225	1·42	158·5	3 50	120	114	·82	137	250·20	361	..	·5	..	·31	
	105	·63	66·12	..	166·6	225	1·68	133·9	4 0	120	114	1·05	167	311·88	472	..	32·7	..	19·6	
	105	·59	61·94	..	177·9	231	1·38	167·4	4 0	126	120	·79	141	257·82	416	..	10·5	..	5·8	
	105	·63	66·12	..	166·6	252	1·55	162·5	3 35	147	140	·92	146	324·88	491	..	4·1	..	2·4	
				Average		232	1·52	153·5	3 52											
G. Strauss ..	105	·46	48·50	..	228·2	219	1·13	193·8	3 45	114	109	·67	146	198·17	412	..	34·4	..	15·1	Supplied, September, 1894.
	105	·57	59·85	..	184·2	219	1·28	171·2	3 30	114	109	·71	125	220·40	368	..	13·0	..	7·0	
	105	·49	51·44	..	214·2	180	1·38	130·4	3 45	75	71	·89	152	196·91	383	..	33·8	..	39·1	
	105	·50	52·50	..	210·0	270	1·25	216·0	4 30	165	157	·75	150	285·00	343	..	6·0	..	28·6	
	105	·49	51·44	..	214·2	180	1·24	145·2	4 0	75	71	·75	153	171·76	334	..	69·0	..	32·2	
	105	·50	52·50	..	210·0	184	1·15	160·0	4 0	79	75	·65	130	159·10	303	..	50·0	..	23·8	
				Average		209·6	1·23	169·4	3 58											
Sturm & Co. ..	105	·51	53·54	..	205·8	201	1·08	186·10	3 50	96	91	·57	112	163·56	305	..	19·7	..	9·5	Supplied, January, 1894.
	105	·41	43·05	..	256·0	219	·83	263·8	3 30	114	109	·42	102	138·70	322	·78	..	3·0	..	
	105	·56	58·79	..	187·5	201	1·32	152·2	4 20	96	91	·76	136	206·51	356	..	35·3	..	18·7	
	105	·57	59·85	..	184·2	204	1·37	149·9	3 55	99	94	·80	140	219·60	372	..	34·3	..	18·6	
				Average		206·2	1·15	188·2	3 54											

Experiment 6.—Three-Fourths of Breaking Voltage.

Another series of tests were carried out in the same way as Experiment 5, except that the lamps were tested electrically

and photometrically after, as well as before being subjected to a high voltage. The object was to find what would be the effect on the electrical efficiency, candle power, and the resistance of the same kind of lamps, when slowly raised from normal pressure to three-fourths of their mean breaking voltage. It is interesting to notice in Table 2, that the candle power is found to be rather *more* after the filaments have been raised to a high temperature and retested at the initial pressure.

From the trials of the numerous lamps that have been supplied to the Post Office, Table 3 has been calculated, shewing their behaviour before and after being raised to ¾ of their breaking voltage. They have been arranged in order of their initial efficiencies, and the percentage difference of candle-power and watts per candle-power, before and after raising the voltage, exhibited in tabular form. With the exception of the watts per candle-power in the case of the group of lamps of the initial efficiency 4 to 4·5, these differences are positive.

TABLE 1—*continued.*

BEHAVIOUR OF 105 VOLT 16 C.P. LAMPS

On running up to Breakage Voltage.

Maker.	At Starting.				At Breaking.				Difference between starting and breaking.										Remarks.
	Volts.	Amps.	Watts.	Resistance.	Volts.	Amps.	Resistance.	Time of running up.	Volts.		Amperes.		Watts.		Resistance.				
															Actual.		Hot.		
				Cold.			Hot.		Actual.	Per cent.	Actual.	Per cent.	Actual.	Per cent.	+	−	+	−	
								mins. secs.									Per cent.		
Conze & Simon	105	·60	63·00	175·0	225	1·42	158·4	3 30	125	119	·82	137	256·55	407	..	16·6	..	9·4	Supplied, September, 1894.
	105	·60	63·00	175·0	240	1·48	162·2	4 20	135	129	·88	147	292·10	464	..	12·8	..	7·3	
	105	·58	60·89	181·0	225	1·38	163·0	4 5	125	129	·80	138	249·61	410	..	18·0	..	9·9	
	105	·57	59·85	184·2	219	1·40	156·4	4 10	114	109	·83	146	246·70	412	..	27·8	..	15·1	
	105	·59	61·94	177·9	225	1·38	163·0	4 5	125	129	·79	134	248·56	401	..	14·9	..	8·3	
				Average	236	1·41	160·6	4 2											
Lowcock, Hill & Co.	105	·51	53·54	205·8	225	1·08	208·3	3 35	125	129	·57	112	189·46	357	2·5	..	1·22	..	Supplied, March, 1894.
	105	·54	56·69	194·4	219	1·14	192·1	4 0	114	109	·60	111	192·91	340	..	2·3	..	1·18	
	105	·49	51·44	214·2	228	1·13	201·7	3 50	123	117	·64	131	206·21	401	..	12·5	..	..	
	105	·50	52·50	210·0	225	1·10	204·5	3 50	125	129	·60	120	195·00	371	..	5·5	..	..	
	105	·50	52·50	210·0	219	1·10	199·1	3 30	114	109	·60	120	188·40	359	..	10·9	..	..	
				Average	206·9	1·11	201·1	3 45											
P. Walters & Co.	105	·57	59·85	368	221	1·20	184·3	4 0	116	110	·63	111	205·35	343	·1	..	5·4	..	Supplied, March, 1894.
	105	·56	58·79	362	186	1·32	140·9	3 10	81	77	·76	136	186·71	333	..	46·6	..	24·9	
	105	·57	59·85	363	183	1·42	128·8	3 25	78	74	·85	149	200·00	334	..	55·4	..	30·1	
	105	·57	59·85	374	174	1·38	126·1	3 24	69	65	·81	148	180·25	301	..	58·1	..	31·5	
	105	·56	58·79	364	258	1·31	197·0	4 0	153	146	·95	170	279·16	475	9·5	..	5·9	..	
	105	·57	59·85	376	171	1·30	131·5	3 20	66	62	·73	128	162·50	272	..	52·7	..	28·6	
				Average	198·8	1·32	151·4	3 33											
As now made by the Crystal Electric Lamp Company, Limited.																			
No. 7	111	·46	51·00	384	241	1·20	180	4 30	105	94·6	·74	161	208·2	408	..	61	..	25·3	Supplied, May, 1895.
,, 10	114·5	·39	44·66	460	293	1·08	212	4 15	104·5	91·2	·64	164	180·94	405	..	81	..	27·6	
,, 11	126	·41	51·66	440	307	1·00	180	3 50	54	42·8	·59	144	128·34	248	..	127	..	..	
,, 12	114	·46	52·44	390	248	1·09	179	3 45	81	71·0	·63	137	160·06	305	..	16	..	27·8	
,, 13	118	·41	48·38	464	287	·96	218	4 20	92	77·3	·55	134	153·22	317	8	..	..	24·0	
,, 14	119	·48	57·12	407	248	1·13	191	4 5	97	81·5	·65	135	186·99	327	..	25	..	23·0	
				Average	206	1·06	193	4 15											

Table 2.

Behaviour of 105 Volt 16 C.P. Lamps,

Before and after running up to ¾ of Mean Breaking Voltage, set out in Table 1.

Firm.	Before running up Voltage.						At Limiting Voltage.			After running up Voltage.			Percentage Difference before and after increased Voltage.								Remarks.
	Resist. Cold.	C.P. at 105 Volts.	Amps. at 105 Volts.	Watts.	Watts per Candle.	Resist. Hot.	Volts.	Amps.	Resist. Hot.	Time of running up.	C.P. at 105 Vaults.	Amps. at 105 Volts.	Watts.	Watts per Candle.	Resistance Cold.	Resistance Hot.	C.P. +	C.P. −	Amperes. +	Amperes. −	Watts. +	Watts. −	Resistance. Cold. +	Resistance. Cold. −	Resistance. Hot. +	Resistance. Hot. −	
										m. s.																
Edison Swan ..	..	12·5	·51	53·54	4·24	205·8	180	1·14	157·9	2 40	12·7	·54	56·69	4·46	..	194·4	1·6	..	5·9	..	5·9	..	..	..	..	5·53
	..	11·4	·45	50·40	4·42	218·7		1·09	165·1		13·2	·53	4·21		..	198·1	15·8	..	10·4	..	10·3	..	..	..	..	9·42
	..	14·5	·55	57·74	3·98	190·9		1·17	153·8		16	·61	64·04	4·00	..	172·1	10·3	..	10·9	..	10·9	..	..	..	..	9·85
		Average		Average	4·21				Average		13·9	..	..	4·22	Average		9·2	..	..	..	9·0					
General Electric ..	..	16·7	·66	69·30	4·15	159·0	174	1·12	154·4	2 40	22·8	·75	78·7	3·45	..	139·9	36·5	..	13·6	..	13·5	..	..	..	..	12·0
	..	19·7	·66	69·30	3·92	159·0		1·12	154·4		24·7	·75	78·7	3·19	..	139·9	25·4	..	13·6	..	13·5	..	..	..	..	12·0
	..	16·9	·66	69·30	4·10	159·0		1·12	154·4		21·4	·75	78·7	3·68	..	139·9	26·6	..	13·6	..	13·5	..	..	..	..	12·0
		Average		Average	4·05				Average		22·9	..	..	3·44	Average		29·5	..	..	..	13·5					
G. Straus ..	..	421·7	·47	49·35	5·87	223·0	150	·73	205·5	2 30	9·3	·48	50·40	5·42	419·4	218·7	10·9	..	2·1	..	2·1	..	·54	..	2·06	
		423·4	·47	49·35	4·88	223·0		·73	205·5		10·6	·48	50·40	4·75	420·0	218·7	4·9	..	2·1	..	2·1	..	·80	..	2·06	
		416·0	·48	50·40	4·75	218·0		·74	202·7		12·0	·56	52·5	4·38	411·8	210·0	18·9	..	4·17	..	4·17	..	1·01	..	3·98	
		Average		Average	5·16				Average		10·6	..	..	4·85	Average		11·5	..	..	..	2·79					
Stürm & Co. ..	..	11·03	·55	57·74	5·23	190·9	150	·84	178·6	2 30	11·49	·58	60·87	5·93	347	181·0	4·17	..	5·4	..	5·4	..	·51	..	5·19	
		9·33	·57	59·85	6·41	184·2		·86	174·4		11·0	·59	61·94	5·63	373·4	177·9	17·9	..	3·5	..	3·5	..	·16	..	3·4	
		Average		Average	5·82				Average		11·16	..	..	5·78	Average		..	..	..	..	4·4					

Table 2.—*continued.*

Behaviour of 105 Volt 16 C.P. Lamps

Before and after running up to ¾ of Mean Breaking Voltage, set out in Table 1.

Firm.	Before running up voltage.					At limiting voltage.			After running up Voltage.				Percentage difference before and after increased voltage.								Remarks.
	Resistance. Cold.	C.P. at 105 volts.	Amps. at 105 volts.	Watts.	Watts per candle.	Resistance. Hot.	Volts.	Amps.	Resistance. Hot.	Time of running up.	C.P. at 105 Volts.	Amps. at 105 Volts.	Watts.	Watts per Candle.	Resistance. Cold.	Resistance. Hot.	C.P. +	C.P. −	Amperes. +	Amperes. −	Watts. +	Watts. −	Resistance. Cold. +	Resistance. Cold. −	Resistance. Hot. +	Resistance. Hot. −	
										m. s.																
Conze and Simon	345	12·3	·57	59·85	4·86	184·2	168	1·1	152·7	3 15	15·6	·63	66·12	4·24	396	166·6	26·8	..	10·5	..	10·5	..	..	2·6	..	9·5
	340	13·1	·58	50·89	4·64	181·0		1·2	140·0	2 50	15·7	·64	67·2	4·28	330	164·0	19·8	..	10·3	..	10·3	..	..	2·94	..	9·4
	350	11·2	·57	59·85	5·34	184·2		1·1	152·7		16·1	·64	67·2	4·17	397	164·0	43·7	..	12·3	..	12·3	..	..	3·71	..	11·0
		Average		Average	4·94				Average		15·8	..	..	4·23	Average		30·1	..	..	..	11·0					
Lowcock, Hill, & Co.	402·7	11·7	·51	53·54	4·57	205·8	168	·82	204·8	3 15	8·3	·52	65·1	7·84	407	201·9	..	29·1	1·96	..	1·96	..	1·06	..	1·89	
	407	11·7	·51	53·54	4·57	205·8		·82	204·8	2 50	14·0	·53	55·6	4·68	406	196·2	19·6	..	3·9	..	3·9	..	..	2·4	..	4·6
	406	12·1	·50	52·50	4·34	210·0		·80	210·0	2 20	13·5	·53	55·6	4·12	404	196·2	11·6	..	6·0	..	6·0	..	..	4·9	..	6·6
		Average		Average	4·46				Average		11·9	..	..	5·54	Average		15·6	..	..	..	3·95					
P. Walters ..	357	11·7	·58	60·89	5·20	181·0	150	·94	159·5	2 5	13·1	·58	60·89	5·26	358	181·0	12·0	..	..	..	..	..	·28	..	..	..
	387	12·7	·54	56·69	4·46	194·4		·90	166·6	2 15	13·3	·54	56·69	4·26	388	194·4	4·7	..	..	..	..	..	1·25	..	..	..
	364	13·5	·57	59·85	4·43	184·2		·95	157·9	2 15	11·8	·56	58·79	4·98	364	187·5	..	12·6	..	1·75	..	1·75	..	..	1·8	..	..
		Average		Average	4·69				Average		12·7	..	..	4·83	Average		8·3									
		At nrml. vltg. of	Amps. at do.								Normal Voltage.	Amps. at ditto.														
As now made by the Crystal Electric Lamp Company, Limited. (B)	449	115	·43	49·4	3·66	267	158	·69	229	2 30	14·9	·43	49·4	3·3	440	267	10·4	..	..	..	..	..	2·0	..	..	
(C)	380	107	·48	51·4	3·15	223		·83	190	2 35	16·6	·49	52·4	3·2	380	218	1·8	..	2·1	..	1·9	..	..	..	..	2·2
(D)	437	115	·44	50·6	4·40	261		·70	226	2 15	12·2	·44	50·6	4·1	435	261	6·1	..	..	..	..	..	·46	..	..	..
		Average		Average	3·74				Average		14·5	..	..	3·5	Average		6·1									

Table 3.

Table Showing Behaviour of 16 C.P. Lamps (100 v. and 105 v.) before and after raising their voltage to 170.

Initial Efficiency, Watts per C.P.	No. of Tests.	Before raising Voltage.		After raising Voltage.		Mean differences °/₀.	
		Mean C.P.	Mean Watts per C.P.	Mean C.P.	Mean Watts per C.P.	C.P.	Watts per C.P.
3·0 — 3·5	29	15·8	3·34	16·1	3·45	+ 1·9	+ 3·3
3·5 — 4·0	93	14·5	3·76	15·5	3·81	+ 6.9	+ 1·3
4·0 — 4·5	66	13·3	4·19	14·86	3·85	+ 11·7	— 8·1
4·5 — 5·0	17	12·7	4·69	13·1	4·91	+ 3·1	+ 4·7

The foregoing results may be summed up thus:—

1. The continuous lighting experiments show that the candle power falls about thirty per cent. in 1000 hours, and the watts per candle rise about 28 per cent. in the same time, as illustrated in the curves (Sheet 1), which connect time with candle power (per centage), and watts per candle.

2. In installation work lamps of about 3¾ watts per candle, burning from 7 to 9 hours a day, behave as regards life and efficiency about the same as when giving continuous illumination, but high efficiency lamps deteriorate more quickly.

3. That good 100 or 105 volt 16 candle power lamps, taking 3¾ watts per candle, should stand a gradual increase of pressure of direct current up to 225 or 230 volts (now made 210) in 3½ minutes before the filament breaks; that when slowly and regularly raised in 2½ minutes to say 170 volts, that is approximately three-fourths of the mean breaking voltage previously alluded to, and afterwards retested at ordinary voltage, the candle power should not be less than 14·4 nor higher than 17·6, while the watts per candle should not exceed 4.

Evidently, in ordinary lighting, the candle-power of each lamp gradually drops, and the watts per candle rise; but when the pressure is raised in a short time to three-fourths of the breaking voltage the candle-power increases, and so also does the current, but the first more rapidly than the second, hence the watts per candle should not exceed 4 for lamps of 3¾ watts per candle after the increased pressure has been applied to the filaments. This is rather a curious fact, and seems to indicate that when the filament is raised to a temperature considerably above that of normal, it, if of good quality, undergoes a beneficial change, as if the sudden cooling, after being at an abnormal temperature, causes some molecular alteration, which not only lessens its diameter and resistance, but affects its emissivity. Under these conditions the temperature of the filament is increased, and thus produces a greater amount of light.

To ascertain the charac'eristic behaviour and actual cost of various lamps referred to in this paper I have selected a number indiscriminately and divided them into three groups according to their initial efficiency, thus:—

1. Those taking from 2 to 3 watts per candle Sheet 2. Group F.
2. „ „ „ 3 to 4 „ „ „ „ „ G.
3. „ „ over 4 to „ „ „ „ „ H.

Group F included three lamps only. Group G nineteen lamps, and Group H fourteen lamps, and it was so arranged that these numbers were maintained throughout 1000 hours by renewal of lamps whose initial efficiencies were within the limits specified for that particular group. Three tables have been calculated, giving at intervals of 100 hours the candle power per lamp, the watts per candle per lamp, and the total number of lamps replaced, and the results are plotted upon Sheets 2 and 3. Sheet 2 connects time with the candle power and watts per candle per lamp for each group, and the curves thereon correspond with the results tabulated below.

Table 4.

Table showing Candle Power per Lamp, Watts per Candle per Lamp, and Time.

Lamps of Initial Efficiency = 2—3 Watts per Candle.

Time. Hours.	No. of Lamps.	C. P. per Lamp.	Watts per Candle per Lamp.	Lamps replaced Total.	Remarks.
0	3	12·57	2·72	0	
100	„	10·02	4·57	0	
200	„	13·25	3·57	1	
300	„	12·25	3·7	1	
400	„	11·69	3·73	1	
500	„	12·64	3·6	2	
600	„	10·04	3·77	3	
700	„	8·81	4.34	3	
800	„	8·24	4·55	3	
900	„	8·09	4·72	4	
000	„	7·83	4·84	4	Therefore in 1,000 hours each of the original 3 lamps had been replaced, and 1 twice.

Table 5.

Tables showing Candle power per Lamp, Watts per Candle per Lamp, and Time.

Lamps of Initial Efficiency 3—4 Watts per Candle.

Time. Hours.	No. of Lamps.	C. P. per Lamp.	Watts per C. P. per Lamp.	Lamps replaced Total.	Remarks.
0	19	15·58	3·57	—	
100	„	15·22	3·65	1	
200	„	14·7	3·78	1	
300	„	13·97	3·94	2	
400	„	13·68	4·05	5	
500	„	13·26	4·20	5	
600	„	13·61	4·20	7	
700	„	13·14	4·34	7	
800	„	12·82	4·47	8	
900	„	12·48	4·62	9	
1,000	„	12·92	4·37	12	Out of the 19 original lamps, 12 were replaced in 1,000 hours.

Table 6.

Tables showing Candle Power per Lamp, Watts per Candle per Lamp, and Time.

Lamps of initial efficiency over 4 Watts per Candle.

Time. Hours.	No. of Lamps.	C. P. per Lamp.	Watts per C. P. per Lamp.	Lamps replaced Total.	Remarks.
0	14	13·43	4·50	—	
100	„	13·32	4·55	0	
200	„	13·16	4·61	0	
300	„	12·91	4·66	0	
400	„	12·68	4·77	0	
500	„	12·33	4·87	0	
600	„	11·94	5.00	0	
700	„	11·5	5·20	0	
800	„	10·93	5·48	0	
900	„	10·68	5·54	1	
1,000	„	10·71	5·55	2	In 1,000 hours 2 of the 14 original lamps were replaced.

It will be seen that the only group which started at about its stated candle-power was Group G, of 3 to 4 watts per candle. This began with a mean candle-power of 15·56, and at the end of 1,000 hours' lighting reached an approximately constant candle-power of 12·5 per lamp. The watts per candle started at 3·57 per lamp and finally attained 4·7.

Group H, that of over 4 watts per candle, commenced with a candle-power of 13·43, and fell to about 10·5 in 1000 hours, while the watts per candle varied from 4·5 to 5·6 per lamp.

Group F comprises high efficiency lamps, and comes out somewhat unsatisfactorily, as the starting candle-power of the lamps is only 12·57. It should, however, be remembered that it consisted of three lamps only, hence a good mean result could not be obtained. During the 1000 hours the candle-power fluctuated considerably, owing to new lamps taking the place of old ones, and at the end of this time it dropped to 7·82 per lamp, while the watts per candle throughout the time changed from 2·72 to 4·84. It will be seen in this case that at the end of 1000 hours the so-called high efficiency lamps required more watts per candle than those of Group G.

Sheet 3 graphically represents the lamps replaced in each group, expressed as a percentage at intervals of 100 hours taken from the following figures.

Table 7.

Percentage Number of Lamps Replaced.

Time. Hours.	Group H.	Group G.	Group F.	Remarks.
0	—	—	—	
100	0	5·3	0	
200	0	5·3	33·3	
300	0	10·5	33·3	
400	0	26.3	33·3	
500	0	26·3	66·7	
600	0	36·8	100·0	
700	0	36·8	100·0	
800	0	42·1	100·0	
900	7·1	47·4	133·3	
1,000	14·3	63·2	133·3	

Group F = 3 lamps of initial efficiency = 2—3 watts per candle.
„ G = 19 „ „ „ „ = 3—4 „ „ „
„ H = 14 „ „ „ „ over 4 „ „ „

If the number of lamps in either group was sufficiently large, the curves on Sheet 3, after a time, would become straight lines at different inclinations to the axis of time. The tangent of this angle denotes the rate of replacing the lamps with time. One hundred divided by this, when the constants for percentage of lamps and time are suitably taken, would, therefore, give the mean life of the lamps, since, at that time, all the lamps would have been replaced.

Thus in figure 2:—

$$\frac{y}{x_1} = \tan\theta. \text{ or } x_1 = \frac{y}{\tan\theta.}$$

$$\therefore \text{ Mean life of lamps} = \frac{100}{\tan\theta.}$$

Owing to the small number of lamps in each group the curves are not continuous, but it will be seen from curve F in sheet 3, that all the high efficiency lamps are replaced in about 700 hours; in the case of curve G all the three to four watt lamps would be replaced in about 1350 hours, and in the case of the low efficiency lamps in curve H, there were only two failures out of fourteen lamps after about 1000 hours. It is, therefore, impossible to approximate the mean life of the lamps plotted in curve H, but it can certainly be taken at considerably over 1000 hours.

From sheet 2 it will be manifest that the lamps of from 3 to 4 watts per candle give the greatest candle power per lamp—from 700 to 1000 hours—with the least expenditure of energy per candle. To see which type of lamp was the most economical to use, the curves on sheet H, connecting cost per candle hour and time were calculated, as in the following Tables, 8, 9, and 10, at intervals of 100 hours from the formula:—

$$\text{Cost per candle hour} = \frac{\text{The price of total number of lamps used.}}{\text{Total candle hours up to that point.}} + \frac{\text{Mean watts per candle up to that point}}{1000} \times \text{price of B.T.U.}$$

In the following tables, 8, 9, and 10, the cost per lamp has been taken at 1s. 3d. throughout.

Table 8.

Cost per Candle Hour.

Lamps of initial watts per candle, 2 to 3.

Time Hrs.	Total Candle Hours.	Watts per Candle power (mean)	Cost per Candle hour.						
			Lamps.	Energy.			Total Cost.		
				B.T.U. at 3d.	B.T.U. at 6d.	B.T.U. at 9d.	B.T.U. at 3d.	B.T.U. at 6d.	B.T.U. at 9d.
			d.	d.	d.	d.	d.	d.	d.
100	1,129	3·64	·0132	·0109	·0218	·0327	·0242	·0351	·0460
200	2,388	3·62	·0083	·0108	·0217	0325	·0192	·0301	·0409
300	3,606	3.64	·0055	·0109	·0218	·0327	·0164	·0264	·0383
400	4,780	3·64	·0041	·0109	·0218	·0327	·0151	·0260	·0369
500	6,035	3·65	·0041	·0109	·0219	·0328	·0150	·0260	·0370
600	7,068	3·64	·0042	·0109	·0218	·0327	·0151	·0260	·0370
700	7,980	3·66	·0037	·0103	·0219	·0329	·0147	·0257	·0367
800	8,840	3·75	·0033	·0112	0225	·0337	·0146	·0258	·0371
900	9,614	3·83	·0036	·0115	·0229	·0344	·0151	·0266	·0381
1000	10,490	3·92	·0033	·0117	·0235	·0352	·0151	·0268	·0386

Table 9.

Cost per Candle Hour.

Lamps of initial watts per candle 3 to 4.

Time Hrs.	Total Candle Hours.	Watts per Candle power (mean)	Cost per Candle hour.						
			Lamps.	Energy.			Total Cost.		
				B.T.U. at 3d.	B.T.U. at 6d.	B.T.U. at 9d.	B.T.U. at 3d.	B.T.U. at 6d.	B.T.U. at 9d.
			d.	d.	d.	d.	d.	d.	d.
100	1,540	3·61	·0103	·0108	·0217	·0325	·0211	·0320	·0428
200	3,034	3·67	·0052	·0110	·0220	·0330	·0162	·0272	·0382
300	4,461	3·74	·0037	·0112	·0224	·0337	·0149	·0261	·0374
400	5,852	3·80	·0032	·0114	·0228	·0342	·0146	·0260	·0374
500	7,200	3·87	·0026	·0116	·0232	·0348	·0142	·0258	·0374
600	8,574	3·91	·0024	·0117	·0235	·0352	·0141	·0259	·0376
700	9,905	3·97	·0021	·0119	·0238	·0357	·0140	·0259	·0378
800	11,200	4·02	·0019	·0121	·0241	·0362	·0140	·0260	·0381
900	12,465	4·08	·0018	·0122	·0245	·0367	·0140	·0263	·0385
1000	13,760	4·10	·0018	·0123	·0246	·0369	·0141	·0264	·0387

In the instances taken, an inspection of these curves show that even when the price per Board of Trade Unit is as low as 3d. at the end of 1000 hours, the high efficiency lamp has to give way to those of Group G. The same remark holds in a less degree when the price of a Board of Trade Unit was taken at 6d., but when the price of energy is raised to 9d. per unit, the lamps occupy the relative positions indicated by their initial efficiencies, though there is not much difference between Curves G3 and F3. In this comparison, however, it must be borne in mind that the candle power of the high efficiency lamps was considerably under the normal at the start, and it is reasonable to expect, that if the lamps as per Group F could be obtained, giving a mean candle power of 16 at the start, they would be found to be more economical even when the price per unit is as low as 3d., therefore, ignoring the inconvenience due to the large variation of the candle power of separate lamps, these would be the most economical of the three types to use.

Table 10.

Cost per Candle Hour.

Lamps of initial watts per candle over 4.

Time Hrs.	Total Candle Hours.	Watts per Candle power (mean)	Cost per Candle Hour.						
			Lamps.	Energy.			Total C st.		
				B. T. U. at 3d.	B. T. U. at 6d.	B. T. U. at 9d.	B. T. U at 3d.	B. T. U. at 6d.	B. T. U. at 9d.
			d.	d.	d.	d.	d.	d.	d.
100	1,338	4·53	·0112	·0136	·0272	·0408	·0248	·0384	·0520
200	2,660	4·55	·0056	·0137	·0273	·0410	·0139	·0329	·0466
300	3,963	4.58	·0038	·0137	·0275	·0412	·0175	·0313	·0450
400	5,244	4 62	·0029	·0139	·0277	·0416	·0168	·0306	·0445
500	6,490	4·66	·0023	·0140	·0280	·0419	·0163	·0303	·0442
600	7,698	4·71	·0019	·0141	·0283	·0424	·0160	·0302	·0443
700	8,862	4·77	·0017	·0143	·0286	·0429	·0160	·0303	·0446
800	9 976	4·85	·0015	·0146	·0291	·0437	·0161	·0306	·0452
900	11,070	4.92	·0015	·0148	·0295	·0443	·0163	·0310	·0458
1000	12,150	4·97	·0014	·0149	·0293	·0448	·0163	·0312	·0462

As compared with Professor Ayrton's and Mr. Medley's excellent paper I think the foregoing results based upon the greater number of lamps, lamps of different makers, and lamps of different efficiencies, furnish a more satisfactory idea of the cost per candle-hour, and also of the most economical lamp to employ. As regards high efficiency lamps, if they could be relied upon to start at their marked candle power, they would certainly be found of good service for domestic lighting and for large open spaces where a considerable reduction of candle power of individual lamps would not cause inconvenience: but in large establishments like the Post Office, where each lamp must give a fairly uniform light over a long period, they could not be tolerated.

Montgomery Lamps.

105 Volts. B4.

Tests made July-August, 1896.

Hours run.	Candle Power.	Current.	Watts per Candle.	Remarks.
0	27·7	·52	1·97	
50	25·4	·52	2·15	
100	17·9	·50	2·93	
150	13·7	·48	3·68	
200	13·0	·48	3·87	
250	11·3	·475	4·41	
300	11·1	455	4·30	
350	11·0	·465	4·44	
450	10·6	·45	4·46	
530	10·5	·45	4·5	
650	9·8	·44	4·71	
750	9·0	·44	5·13	
800	8·8	·44	5·25	Lamp considered useless, so test discontinued.

Montgomery Lamps.

B3. 105 Volt Lamp.

Hours run.	Candle Power.	Current.	Watts per Candle.	Remarks.
0	21·1	·48	2·39	
50	21·2	·485	2·40	
100	18·7	·475	2 67	
150	15·2	·465	3·21	
2 0	13·8	·46	3·50	
250	12·3	·455	3·88	
300	12·3	·445	3 80	
350	12·3	·445	3·80	
450	11·1	·43	4·07	
550	10 2	·43	4·43	
650	10·2	·42	4·32	
750	9·5	·42	4·64	
800	9·0	·42	4·9	Lamp considered useless, so test discontinued.

A copy of the present Post Office specification for glow lamps is given. It is not yet regarded by me as being in its final form, but so far, the conditions laid down have been satisfactorily met by certain lamp makers, and this has resulted in a considerable improvement in the lamps supplied. We frequently find that

weakness is apparent at the lamp mounts through the wires being too thin, and the joints between the metal and filament being defective.

Montgomery Lamps.
105 Volts. No. 3.

Hours run.	Candle Power.	Current.	Watts per Candle.	Remarks.
0	16·2	·36	2·33	
50	15·6	·39	2·62	
100	14·1	·38	2·83	
150	12·0	·355	3·11	
200	11·1	·34	3·22	
250	9·9	·34	3·61	
300	9·5	·325	3·59	
350	9·7	·335	3·63	
450	8·6	·32	3·91	
550	8·7	·32	3·86	
650	8·25	·32	4·07	
750	7·6	·32	4·42	
800	7·42	·32	4·53	Lamp considered useless, so test discontinued.

Test No. 2, in conjunction with 1 and 3, has proved to be a valuable means of finding out the good, bad, and indifferent qualities of lamps; it is found to give a good forecast of what a lamp would do when used in the ordinary way, and may be regarded as equivalent to so many hundred hours' run. I also attach results recently obtained with some new 2-watt lamps. The drop in candle power with these lamps, as with all other economical lamps that I have tested, is very large during the first two to three hundred hours run, after which time they seem to reach a steady state and behave like ordinary 3 to 4 watt lamps; but at this stage the illuminating power is no longer serviceable for Post and Telegraph work, hence the lamps would have to be frequently renewed.

These experiments have been tedious and exhaustive. They have been carried out under the indefatigable supervision of Mr. Isaac Probert.

POST OFFICE TELEGRAPHS.

ELECTRIC GLOW LAMPS.

Specification referred to in the accompanying form of tender.

Size of Lamp and Terminal.—The glow lamps are to be to the size of a sample which is to be submitted for approval with the tender. In the case of lamps with screw holders, the screw-terminal is to be strictly in accordance with a standard which will be supplied to the contractor, and to be of such a size that it can be screwed home in the Post Office standard gauge and accurately fitted.

Lamps to be selected for Test.—From the bulk of each delivery a number of lamps will be selected at random and tested electrically and photometrically. This number will vary according to the quantity delivered, viz., 3 per cent. of a delivery of 1000 lamps or under, 2 per cent. of a delivery of 1000 lamps, and up to 3000, and 1 per cent. of a delivery of over 3000 lamps, will be tested. The Postmaster-General reserves the right to reject the whole delivery if more than 25 per cent. of the total number so selected fail to pass either or all the tests hereafter specified. If further tests are undertaken at the contractor's request, it will be at his risk and cost.

Tests.—The following tests will be applied to all the selected lamps:—

1. A photometric test to determine the actual candle power of the new lamp at its standard pressure, and an efficiency test to determine the watts per candle. The limits of candle power, and the maximum watts per candle power allowable for each kind of lamp tendered are set out in the attached table.

2. After being so tested, the pressure at the lamp terminal will be gradually raised until it reaches in 2½ minutes the pressure stated in column 5 of the table. This pressure reached, the current will be at once turned off.

3. The lamps will then be retested as described in Test No. 1. The limits allowable for each kind of lamp as regards candle power, and the maximum watts per candle power, are set forth in the attached table.

4. In lieu of Tests 2 and 3 a proportion of the lamps not exceeding one-third of the whole number selected for test, will be raised gradually in three minutes to the pressure stated in Column 7 of the table. The lamp under test must not fail in any way while the pressure is being increased from its normal voltage to that named in column 7 of the table.

5. The candle power of all lamps tendered for must be in terms of the English standard candle.

Note.—The Post Office measurements will be made with an improved Trotter photometer, and the standard of light will be either the Vernon-Harcourt or the Hefner-Amyl-Acetate, the former being taken for the purposes of this specification as one English candle, and the latter as ·88 of an English candle.

Signature of person tendering.....
General Post Office.
Date.....

Discussion.

Mr. H. Graham Harris asked what difference there would be in the lamps if alternating current were employed, and how the specification would be altered to meet those conditions.

Prof. Ayrton said there was no question of the value of the investigations carried out by Mr. Preece. One of the things they wanted to know was the behaviour and life of the cheaper form of lamps which had been brought into this country, therefore the life tests were not only of importance to Mr. Preece and Post Office, but to all who were interested in electric lighting by means of glow lamps. He should like to hear how many lamps were used in obtaining the results given. For example, under Table Group A. (Page 392, Electrical Review, September 25th), it was stated that two lamps out of 24 of each make were selected at random, one 16 C.P. and one 8 C.P. Did that mean that tests were made on two lamps only, or were the results obtained from a large number? Tests in his (Prof. Ayrton's) laboratory had shown that unless a large number of lamps of a particular type were tried no results of any great value could be derived because of exceptional lamps of any particular make being extra good or bad. With reference to the

POST OFFICE TELEGRAPHS.—GLOW LAMPS.

Table Referred to in the Accompanying Specification, Dated June, 1896.

Terminals.	Standard C.P.	Standard Volts.	Test No. 1. Candle Power. Maximum.	Test No. 1. Candle Power. Minimum.	Test No. 1. Maximum Watts per Candle.	Test No. 2. Pressure Raised to in 2½ mins. Volts.	Test No. 3. Candle Power. Maximum.	Test No. 3. Candle Power. Minimum.	Test No. 3. Maximum Watts per Candle.	Test No. 4. Pressure Raised to in 3 mins. Volts.
E.S. or B.C.	8	100 or 105	8·5	7·5	3·9	170·2	8·8	7·2	4·1	210
,,	8	110 or 115	8·5	7·5	3·9	174·6	8·8	7·2	4·1	215
,,	16	100 or 105	17	15	3·75	170·2	17·6	14·4	4·0	210
,,	16	110 or 115	17	15	3·75	174·6	17·6	14·4	4·0	215
,,	25	100 or 105	26·5	23·5	3·5	170·2	27·5	22·5	3·75	210
,,	25	110 or 115	26·5	23·5	3·5	174·6	27·5	22·5	3·75	215
,,	32	100 or 105	34	30	3·4	170·2	35	29	3·65	210
,,	50	100	53	47	3·3	..	..	..	..	..
Lug	100	105	106	94	2·9	..	..	..	..	..

Marking.—Each lamp is to have distinctly marked on the glass the voltage, the candle-power for which it is designed, and the maker's name, with the normal watts per candle-power.

Examination and rejection of Broken or Defective Lamps.—Each lamp will, on receipt, be tested for continuity of circuit. All lamps having broken filaments, loose terminals, or which are otherwise of defective manufacture, will be rejected, and an equivalent number of good sound lamps must be supplied free of charge by the contractors.

breakage tests and running up the pressure nearly twice, he thought if the results were borne out they were of very great importance. The least value that Mr. Preece had arrived at under the most favourable conditions was ·015d., it ought to be borne in mind that even that most favourable result was a good deal higher, not lower, than lighting by gas with ordinary Argand burners, and was far dearer than gas with the Welsbach lamp. He had been recently carrying out life tests on a lamp which was not before the public, the filament of which was carbide of silicon. The speaker spoke eulogistically of this lamp, and added that after a 1,000 hours the consumption was not higher than 3·75 watts per candle. He had been occupied in considering whether the candle-power rise was due to increase of vacuum, and had found by means of an induction coil that lamps in which the light improved was due to an improvement in the vacuum. Generally speaking lamps in which the C.P. rose were incomplete, they were sold as complete lamps, but the filament gradually changed until the lamp was very much improved.

Professor Fleming expressed surprise that Mr. Preece had adopted as his standard of comparison the standard candle on the Rumford method of shadow photometry. He, the speaker, had abandoned all forms of standard candle many years ago. The standard candle power in the Act of Parliament and in the spermaceti were quite different matters. Photometry was not a question of instrument it was one of observer, and for that reason he objected to all comparisons taken through red and green glass. What they wished to get at was the brightness upon a white surface as compared with the surface produced by a standard source of light. The Hefner lamp had been used a good deal in Germany, but was too red a standard, in addition to which there were difficulties in using it on account of ventilation. The Vernon Harcourt was a standard of very great value, and many observers had given it the first place. Mr. Preece had not referred to the standard which was a modified platinum standard first suggested by Violle. In using an incandescent lamp as a secondary standard there was a difficulty in measuring the rate of decay. He, the speaker, had adopted a method of using 16 C.P. filaments in large bulbs, and such secondary standards were exceedingly valuable. He should like to see in the first paragraph of the specification a more definite method suggested of placing the filament with respect to the photometer. Very little alteration in the filament would mean a variation of C.P. He should like to see a final definition of the standard candle; at the present moment it was not sufficiently well defined. After referring to other clauses he suggested that the specification should be further discussed before final adoption, otherwise it might deal very differently with different classes of lamps.

Mr. Swan thought that the short test described in the paper was by no means a bad one, and very valuable information was derived from it If the voltage was raised gradually during 2½ minutes to 170 volts, and if the lamp did not break he thought it strong evidence that the lamp was representative of a class, supposing it to be taken from a group of lamps.

Major-General Webber said, in spite of the long monopoly and that the number of manufacturers had trebled since 1884, no one appeared to have thought it worth while to prepare a specification on behalf of the consumers. He thought that the specification would be an admirable document if minor alterations were made. Lamp manufacturers, however, he thought, had used all the methods of testing suggested by Mr. Preece. With regard to the specification, he remarked that if Mr. Preece could urge the makers to mark on the lamps, along with the other figures, the normal watts per candle, it would be of great use.

Mr. Preece, in replying, said it had been pointed out by Mr. Robertson that the alternating current had no different effect on the glow lamps. Prof. Ayrton had pointed out that though the cost of electricity was infinitely small, it was still greater than that of gas. Gas per hour was unquestionably cheaper than electric light, the economy of electric light was not during the time it was burning, but one only used it when it was wanted. A gas burner was used twice as long as an electrical one. He suggested that if the Liverpool Corporation worked their trams electrically, they could sell electricity at 3d. per unit. He should adopt the recommendations of Prof. Fleming with regard to the specification, and pointed out that new lamps which they had received had indicated upon them the watts per candle.

MEASUREMENT OF ELECTRIC CURRENTS THROUGH AIR AT DIFFERENT DENSITIES DOWN TO ONE FIVE-MILLIONTH OF THE DENSITY OF ORDINARY AIR.

By Lord Kelvin, J. T. Bottomley, and Magnus Maclean.

Read in Section A, September 19th, 1896.

The apparatus used in these experiments consisted of (1) a cylindrical tube 13 cms. long and 1½ cm. diameter, with two aluminium wires as terminals ground to points 1·5 cm. apart; (2) a large Wimshurst electrostatic machine of 24 plates; (3) a high-resistance mirror galvanometer to measure the current between the aluminium-point terminals inside the tube; (4) an electrostatic voltmeter to measure the difference of potential between the terminals of the tube; (5) a five-fall Sprengel pump, by means of which the density of the air inside the tube could be reduced to any desired extent. The galvanometer was placed on a block of paraffin between one terminal of the electric machine and one terminal of the glass tube. Its deflections were read by a telescope and its sensibility was arranged by external magnets, so that one division of deflection corresponded to 0·3 mikro ampere. Our method of experimenting was to keep the density of the air constant while we varied the difference of potential between the terminals of the tube, and taking simultaneous readings on the voltmeter and on the galvanometer. The electric potential was varied either by varying the speed of rotation of the machine or by varying the distance between the needle-point terminals of the machine, or by a combination of both.

We found that at ordinary atmospheric density it requires a difference of potential of between 2,000 and 3,000 volts at the terminals of the tube before the galvanometer indicates any current. As the difference of potential is now increased, the current through the galvanometer increases at a greater ratio, so that if a curve be drawn with differences of potential as abscissæ and galvanometer readings or currents as ordinates, the curve is always concave towards the axis of current. Through this particular tube the currents at 3,000, 5,000, and 8,000 volts difference of potential were 7·2, 17·6, and 63·2 mikro ampere respectively. As the density of the air was diminished, the difference of potential necessary to start a current, as indicated by the galvanometer, gradually diminished also, till, at a density of about $\frac{1}{1000}$ of the ordinary density, a few score volts were sufficient to start a current. For the same difference of potential the current increased as the density of the air diminished; or otherwise, the same current was obtained by smaller differences of potential as the density of the air was reduced. Thus a current of about 56 mikro ampere was obtained by differences of potential of 7,400, 1,090, 700, 370, 405, 570 volts, when the densities of the air were 1 (ordinary density), 0·058, 0·0093, 0 0007, 0·00006, 0·000024 respectively; or otherwise, when the air pressures were 750, 44, 7, ½, $\frac{1}{22}$, $\frac{1}{65}$ millimetres of mercury respectively.

As the air density was still further reduced, the difference of potential necessary to start a current increased, and the current for the same difference of potential diminished. Thus, when the density of the air was reduced to one five-millionth of the density of air at ordinary atmospheric pressure and temperature, differences of potential of 3,000, 5,000, and 8,000 volts gave currents of 1 3, 4·4, and 14 6 mikro ampere respectively.

If a curve be drawn for a constant difference of potential, with air densities as abscissæ and currents as ordinates, we find the curve rising as the air density is diminished to about $\frac{1}{1000}$ or $\frac{1}{1500}$ of ordinary density; then falling again as the density is still further reduced to about a five-millionth of ordinary density. This is the lowest density we have experimented with, but we have no reason to doubt that at very much lower densities we would still be able to get measurable currents through the tube.

We are now experimenting with a tube 13 cms. long and 1½ cm. diameter having ball terminals of ½ cm. diameter and about 2 mm. apart. The investigation is not complete enough for publishing any results.

REPORT OF THE COMMITTEE ON ELECTROLYSIS.

W. N. Shaw (*Chairman*), Rev. T. C. Fitzpatrick,

W. C. D. Whetham (*Secretary*).

Presented to Section A.

The parts of the original scheme for a report on the present state of electrolysis and electro-chemistry which remain to be dealt with are as follows:—

III. (*d*) Electro-chemical Thermodynamics.
(*e*) Electric endosmose.
(*f*) The theory of ionic migration and ionic velocities.
(*g*) Relations between universal values of the electrical and other physical properties of electrolytes.

IV. A discussion of experimental methods and apparatus.

V. Electro chemical phenomena not usually included as "electrolytic."

VI. Some miscellaneous electrolytic phenomena. The Committee divided the work of sections III. and IV. among its members, electro-chemical thermodynamics, and electric endosmose were assigned to Mr. Shaw, the theory of migration, and ionic velocities to Mr. Whetham, and the discussion of apparatus and methods to Mr. Fitzpatrick. Mr. Whetham has completed the account of the theory of migration, &c., and Mr. Fitzpatrick has dealt with the methods of measuring electrical resistance of electrolytes.

With regard to the section upon the numerical relations of electrical conductivity with other properties of electrolytes, the Committee are of opinion that very valuable results would be obtained by carrying out measurements of the several properties upon identical solutions, with special precautions to protect the experiments against the effects of small impurities. They have learned that Mr. E. H. Griffiths intends, in the course of the coming year, to make a series of observations of the freezing points of solutions, and it is thought that the opportunity of making electrical measurements upon the same solutions should not be allowed to pass. Mr. Whetham has consented to undertake the electrical portion of the work, and it is proposed to apply for a grant of £50 towards the cost of the special apparatus necessary for it.

It is also proposed to print forthwith, and circulate among those most likely to be interested, revised proofs of the portions which have been completed, but not to include them in the published report for this year. It is intended to publish them in the report for 1897, with the remainder of the work that the Committee are able to put before the Association.

The Committee therefore ask for reappointment, with the addition of the name of Mr. E. H. Griffiths, and with a grant of £50.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co. *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

20,261. "Improvements in electric hoists or capstans." W. H. Scott. Dated September 14th.

20,323. "Improvements in telephone apparatus." W. Moseley. Dated September 14th.

20,329. "Improvements in the method of and apparatus for electroplating." M. Black. (W. Webber, United States.) Dated September 14th.

20,354. "Improvements in electrical couplings." J. H. Tucker. Dated September 15th.

20,378. "Improvements in holding and supporting imitation candles in connection with electric light fittings." G. Byng. Dated September 15th.

20,416. "Improvements in or relating to electric alarm bells and like apparatus applicable to cycles and other vehicles." A. J. Boult. (P. Archat, France.) Dated September 15th.

20,419. "Improvements in electric railways." H. de Romanoff. Dated September 15th.

20,467. "Improvements in and relating to quick break double-pole switches and double-pole fuses for use in the controlling and distributing of electric light and power circuits." H. H. B. Deane. Dated September 16th.

20,505. "An improvement in electrodes for secondary voltaic batteries." H. Imray. (R. J. W. Grindle, France.) Dated September 16th. (*Complete.*)

20,513. "Improvements in electromotors especially applicable to motor carriages and other vehicles." J. Vaughan-Sherrin. Dated September 16th.

20,520. "Improvements in apparatus suitable for punching paper for telegraphic purposes." G. M. Gibson. Dated September 16th.

20,539. "Improvements in electrical apparatus for signalling to or from a railway train or locomotive." R. Burn, A. C. Brown, and L. G. Tate. Dated September 17th.

20,579. "Nicol's electric time-handicap starter." W. Nicol. (Date applied for under Patents, &c., Act, 1883, Section 103, February 17th, 1896, being date of application in New Zealand.) Dated September 17th. (*Complete.*)

20,600. "Improvements in and relating to electrodes." J. A. Deuther. Dated September 17th. (*Complete.*)

20,601. "Improvements in and relating to electric furnaces." J. A. Deuther. Dated September 17th. (*Complete.*)

20,604. "Improvements in electrical resistances." W. M. Mordey. Dated September 17th.

20,707. "Improvements in coating tubes by electro-deposition." J. Greenwood. Dated September 18th.

20,745. "An improved method of actuating switches or other controlling gear placed on or below the surface of the roadway in an enclosed conduit or other system of electric traction." R. P. Stevenson. (E. H. B. Tyler, South America.) Dated September 19th.

20,778. "Improvements in safety attachments or devices for preventing the falling of suspended wires, cables, or conductors used for the transmission of electricity." J. Aldworth and J. Shaw. Dated September 19th.

20,796. "Improvements relating to electric railways." H. H. Lake. (R Lundell, United States.) Dated September 19th. (*Complete.*)

20,805. "Improvements in devices for protecting electric circuits and apparatus or instruments from injury by excessive electrical potential." V. A. Fynn. Dated September 19th.

EXPIRING PATENTS.—1882.

We are informed by Messrs. W. P. Thompson & Co. that about 70 applications for electrical patents were filed in the month of October, 1882. Only two of the patents granted on these applications have been maintained to run their full length of term, and as they are of considerable interest, we give short abstracts of them below:—

5,166. "Improvements in circuits for telephonic communication." H. Alabaster and T. E. Gatehouse. Dated October 30th, 1882. This invention relates to the case in which an induction coil and induced currents are used. In one instance the line-wire circuit comprises the secondary wire at each station and the earth return, or it may be a return wire. In each primary local circuit there is a receiver, transmitter and battery. In another instance the line wire includes the secondary wires as above; each primary local circuit includes battery and transmitter, and an independent tertiary local circuit contains the receiver and, if necessary, a battery, or the battery may be in auxiliary circuit with the receiver. In the application of the telephonic receiver, described in Specification No. 2,675, A.D. 1882, to this arrangement of circuit the presence of a battery in the same primary or tertiary circuit as the receiver dispenses with the double wire in the receiver, one only being necessary. If, however, two coils be used in the receiver, the secondary wire of the induction coil is connected to the second coil of the receiver before going to earth. 2 claims.

5,167. "Improvements in telephone receivers." H. Alabaster and T. E. Gatehouse. Dated October 30th, 1882. The present invention consists in part of improvements on that described in Specification No. 2,675, A.D. 1882. Instead of stretching an iron or steel wire, with a wire coiled about it, between two vibrating plates as previously directed, it is attached at one or both ends to rigid supports in the case or is suspended therein, and from about its centre a wire or thin rod of sound-conducting material is fixed at right angles, to the end of which the resonant plate is attached, behind the ear-piece. The variable current passes through the coil surrounding the core wire. The sound-conducting wire or rod may be taken from any part of the core. The core or wire of iron or steel or other magnetic wire is prepared by straining it till it breaks, the broken pieces being used. The molecular change thus induced is stated to add greatly to the adaptability of the core serving as a medium for communicating sounds. A core wire thus prepared may be adapted to a variety of telephonic receivers, one such application being shown and described. The instrument is T-shaped and the vertical core wire is free at the bottom, where it enters a small recess, and at the upper end is fixed to the centre of a resonant disc, secured by its outer circumference in the case formed with a convenient ear-piece. A single-coiled wire surrounds the core and suffices, with the core prepared as described, to produce good and loud articulate sounds when a variable current caused by a suitable transmitter passes through the coil either as a primary, secondary, or tertiary circuit. 4 claims.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d*, (*in stamps*).]

1895.

7,712. "Improvements in electric furnaces." G. D. Burton. Dated April 17th, 1895. Relates to an apparatus for heating metals to the fusing point or to a working heat by means of an arc formed between the metal or ore and an electrolytic bath. The article to be heated forms the cathode and is supported on a hearth of fire-clay, or the like and the solution, which evolves hydrogen when electrolysed, is caused by a pump to flow up to and touch the article thus making the circuit. Hydrogen is evolved and an arc formed between the liquid and article, the hydrogen assisting the arc to heat the article. When the heating is finished the level of the liquid is lowered by means of the pump so as to break the circuit. 12 claims.

7,713. "Improvements in electric furnaces." G. D. Burton. Dated April 17th, 1895. Relates to an apparatus similar to that described in the preceding application, but especially adapted for heating any determinate lengths of bars or blanks. The hearth is divided, and one member may be moved towards or away from the other member, means being provided so that only the part of the bar between the members is heated by the arc. The hearth may be made of asbestos. 8 claims.

9,180. "A hand hoist for raising and lowering arc lamps." G. W. Lunn. Dated May 9th, 1895. The hoist, which is operated by hand, is located in the hollow part of the lamp-post and may be worked by bevel wheels and screws with a coiling barrel or with sheaves, operated by hand. 3 claims.

11,355. "Improvements in or connected with electric cables." H. Edmunds. Dated June 10th, 1895. Has for its object to provide means for preventing the destruction of the insulation of cables encased in a tube by leakage of moisture at the joints wherever connections are made. For this purpose a plug is made surrounding the insulated wires, which plug is forced into or otherwise secured to the enclosing tube and prevents moisture from entering the cable. In the case of stranded wires the strands may be soldered together where they pass through the plug. 3 claims.

11,482. "Improvements in automatic repetition on telegraph cable and other lines." H. A. Taylor and J. A. L. Dearlove. Dated June 12th, 1895. Relates to apparatus for receiving signals from an originating station sent into the line by an automatic transmitter, this apparatus serving to retransmit the same series of signals to the second portion of the line. 2 claims.

11,548. "Improvements in telephone systems" J. E. Kingsbury (Western Electric Co., U.S.A.) Dated June 13th, 1895. A small electric incandescent lamp maintained in connection with the circuit line wires is employed as the call signal or indicator at the exchange. The telephonic currents may be arranged to pass through the lamp or not. 8 claims.

11,549. "Improvements in telephone systems." J. E. Kingsbury (Western Electric Co., U.S.A.) Dated June 13th, 1895. Relates to improved means for signalling from a sub-station to the exchange, and involves the use of annunciators adapted to be operated by a predetermined normal current but to remain inert when traversed by a current materially less than the normal. 20 claims.

11,560. "Improvements in or connected with electric mains or conductors." J. G. W. Aldridge. Dated June 13th, 1895. Bare strip conductors are supported on stepped insulators in culverts, each conductor being in a different vertical and horizontal plane to the others. By this means the liability of the conductors to come into contact through sagging is obviated. 4 claims.